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50¢—Bah humbug

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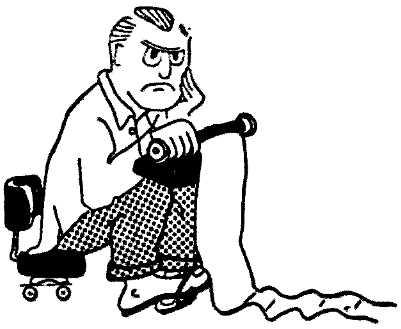

de W2NSD/1

never say die

Saucer talk

Ever since one of our IoAR Directors found himself an observer of a UFO back last January and thus the center of considerable official pressure to keep quiet about the whole thing, I have been reading, asking questions and thinking. I find that the more you read about the UFO's the more unquestionable becomes their existence.

One fact about the UFO's particularly has been bothering me. How do they communicate? If they were using radio on any frequency I think it is safe to say that someone somewhere would by now have heard it. But here we are with no indication whatever of any radio communications by the UFO people. How about that? Obviously they are using some sort of communication system, and a fairly sophisticated one too. Do you suppose that there is some way of talking at a distance without wires other than our familiar "wireless"?

Did someone say telepathy? Well, we do know that this works, though we don't know how to use it at will yet . . . or at least darned few people do. But we do have some people that are adept with it, few though they may be. And if the UFOers were using telepathy of some sort it seems rather likely that someone of us would have detected that, even though we only have a few such receivers. No hint of any telepathy reception.

Could there be something else? I think so. And we have some strong hints as to what it is too, only we don't know much about the whole subject yet. We just barely suspect that there is something and are a long way from being able to use it. We are (I suspect) on the verge of discovering a whole new field for exploration.

About 125 years ago . . . not very long . . . the early experiments with electricity were being carried out. Once electricity had been identified to some degree electro-magnetism turned up, and eventually electro-magnetic waves, which we started using some sixty years ago or so.

For some strange reason gravity is a force that has attracted little attention. Newton gave it some thought, presented us with the math which described its action, and things have pretty much rested there. Up here in New Boston, New Hampshire they've been encouraging anti-gravity research. Obviously a bunch of nuts. We all know that there never will be anti-gravity and that no one but a nut would bother to spend any time and effort trying to achieve the impossible.

Some years ago I met a chap who claimed to have a friend who had electrically generated a gravity field. Seems this friend had tried to demonstrate a working model of this to Dr. Millikan, but this august gentleman refused to observe the demonstration because such a thing was completely impossible. Nothing complicated about the gadget . . . you can make one yourself. All you have to do is put a high voltage on a condenser which you have hanging on a string. You will note that it swings out in the direction of the positive terminal. This is called the

Biefeld-Brown effect, after Professor Biefeld of Dennison University who discovered it and T. T. Brown, a student of his, who has been carrying on the experiments since his death.

As I understand it from the latest reports I have read this principle has been used to make devices up to three feet in diameter which can support their own weight (see August 64 Popular Mechanics cover story) and further development is coming fast.

Where does this connect with amateur radio? Well, electro-gravitics have just barely been discovered now, but from the first look at the subject it seems quite possible that a whole body of developments will come from this basic discovery just as so many things have come from electro-magnetism. It seems quite possible that a communications system may be worked out using gravitics. It is too soon to promise much since no one has yet even discovered a detector to convert electro-gravitics into electrical impulses.

I remember trying to find out about the propagation of a gravity force when I was in school. It took quite a while to even get my question across because apparently no one in the physics department had ever considered that before. Their answer was that there was no propagation of the gravity force because it was always there. Huh? I suspect that gravity is propagated instantaneously and is not limited by the speed of light as are electro-magnetic waves, whatever they are. We still don't know what they are, you know. We have no real idea of what it is that goes to the moon and bounces back when Sam gets a head of steam going down there in Puerto Rico. Something does, obviously.

If gravity is propagated instantaneously then electro-gravitic communication would be fine for interplanetary QSO's, and possibly even intergalactic. We may find the new "bands" or whatever they are awfully busy when we get on there. Imagine if some isolated race, undiscovered on our planet, discovered radio and started tuning twenty meters some day. What a start that would give them. Of course they wouldn't be able to copy much for a long time . . . they would have to decipher our code, figure out sideband, dope out RTTY, multiplex and all that. That would take them quite a while.

It seems quite likely that whatever this communications system is, it is being used by the UFO's.

May I digress for a moment? I just happened to think of a little experiment that K1CLL tried some time ago. He got to

(Continued on page 110)

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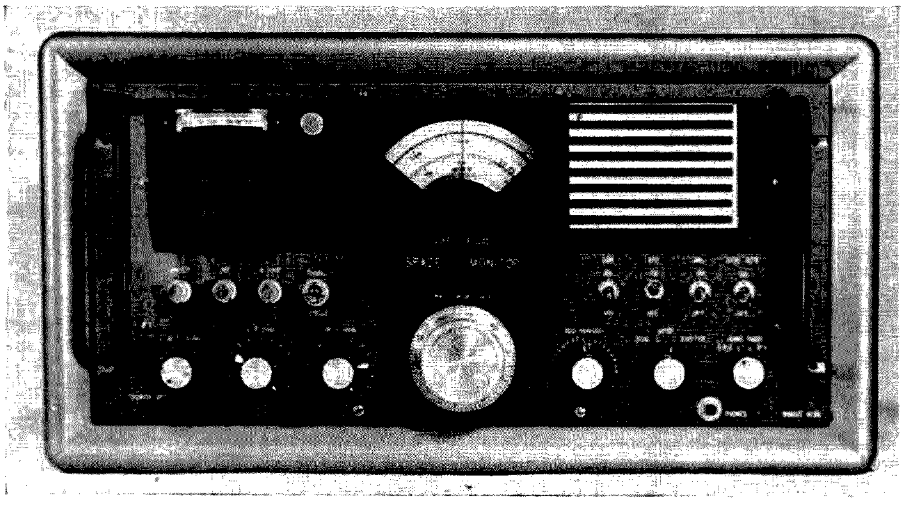
The Space Monitor

This receiver is a composite of previous receivers that I have described. All of the goodies have been retained and newer features have been added to bring this unit to the finest standards of the art. Although the receiver is designed primarily for two meter operation, it also does a good job on the congested twenty meter band with the 2.1 kc mechanical filter. The stability is excellent due to the rugged construction and local oscillator temperature compensation.

Basically there are two receivers in this package. One is a dual conversion aural receiver tuning from 13.5 to 18.5 mc. It has a bandpass of either 6 kc or 2.1 kc. The other receiver is a visual, or panoramic, receiver. It displays the received signal plus a portion of the band on a two inch cathode ray tube. The two make an excellent combination for the HF and VHF bands through the use of a two meter converter built in the package.

The two meter converter is a low noise, high sensitivity unit using a gold plated 416B in the preamp. Two meter sensitivity is in the order of 0.1 μv with a noise figure of 2.8 db. The basic receiver achieves the same sensitivity and noise figure. The panadapter provides a 0.5 μv sensitivity and a band pass of 300 kc at 3 db points. This response is obtained by overcoupling the first two stages of *if*, as shown in the schematic.

The *if* and rf stages employ separate gain controls to tame the strong signals and pick out the weak ones. By proper adjustment of



Front panel of the Space Monitor. The main tuning knob was turned on a lathe and a 2¾" Waldom dial plate fastened to it. The cut-out for the translucent dial was made by drilling a series of holes close together and filing out the arc. A flying cutter was used to make the holes for the panadapter tube and the speaker. Function labeling is engraved.

these controls, signals of 0.1 μv to 1 volt can be handled without overloading.

The signal strength meter is placed just above the panoramic scope tube so that signal strength and quality checks of received signals can easily be compared. This meter is hand calibrated to 60 db over S9 using 50 μv for an S9 signal. A zero set on the front panel allows the operator to compensate for signal to noise adjustments. All pertinent controls are located for the greatest ease of adjustment and can be identified in the front panel photograph.

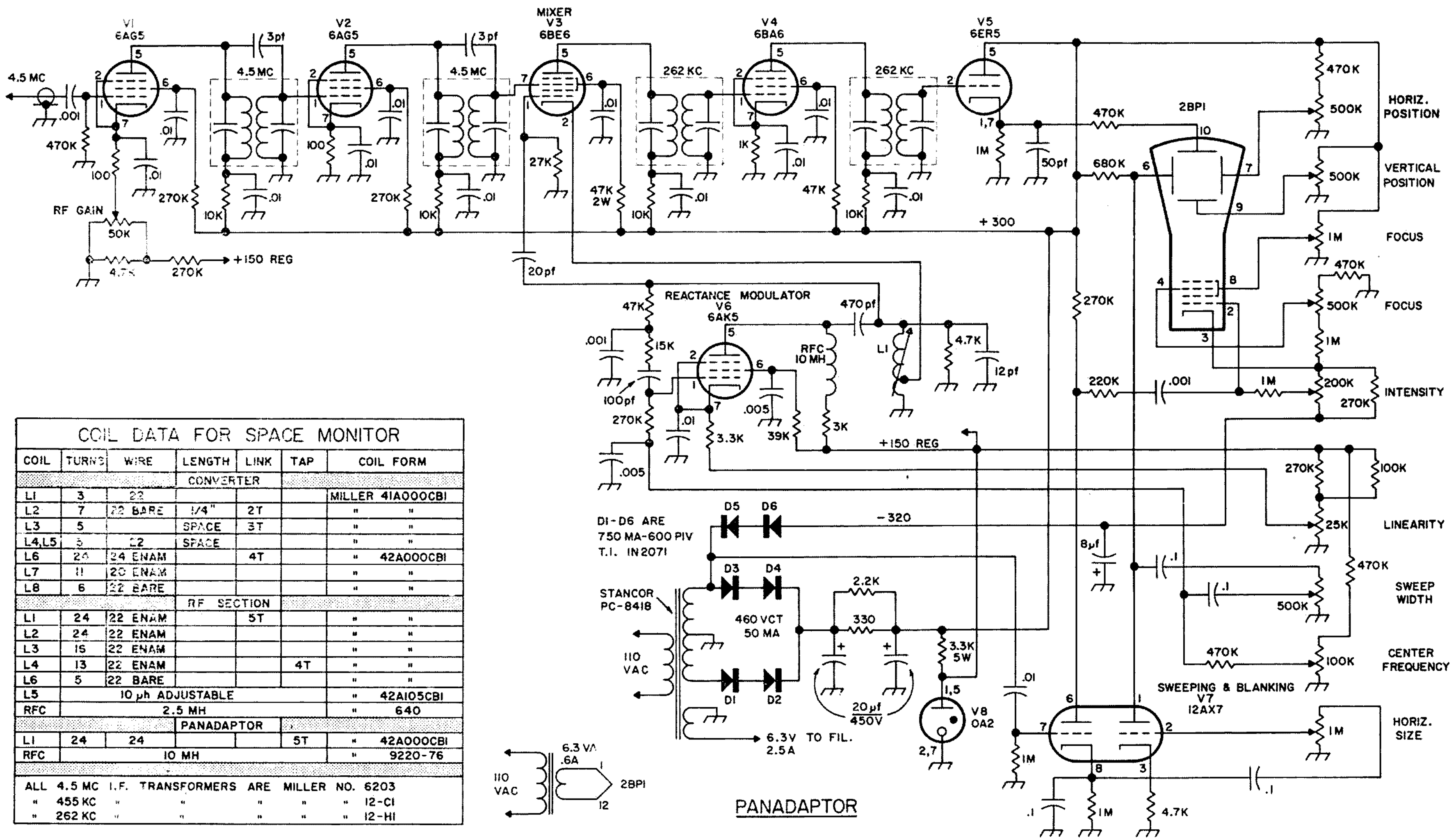
The grill to the right of the main tuning dial covers a small speaker that makes the receiver independent of all accessories except the antenna and power.

Circuits and construction

RF section. The rf section is built in a heavy cast aluminum box that once held a TN-1/APR-1 rf tuner that covered 40 to 90 mc. It was stripped and the only parts used were the box and gear train. The stability that a cast box such as this provides is a necessity for receiving SSB signals. The chassis part of the box is cut out leaving a ⅜ inch ledge for mounting an aluminum plate that is used for the rf components. To allow room for the two meter converter, the tubes, main tuning capacitor and *if* transformer were mounted upside down. The box is mounted with a angle bracket in the back. The front is held on with the gear train plate. The split and spring loaded gears are ideal and reduce backlash to a minimum.

Frequency standard. The crystal frequency standard in this receiver is basically the same as the one described in the October 1962 *73*. However, this one isn't modulated. Half of a 6J6 is a 1 mc crystal oscillator. The other half is a harmonic generator to give good markers up through two meters. A 75 pf trimmer across the crystal is used to adjust for zero beat with WWV.

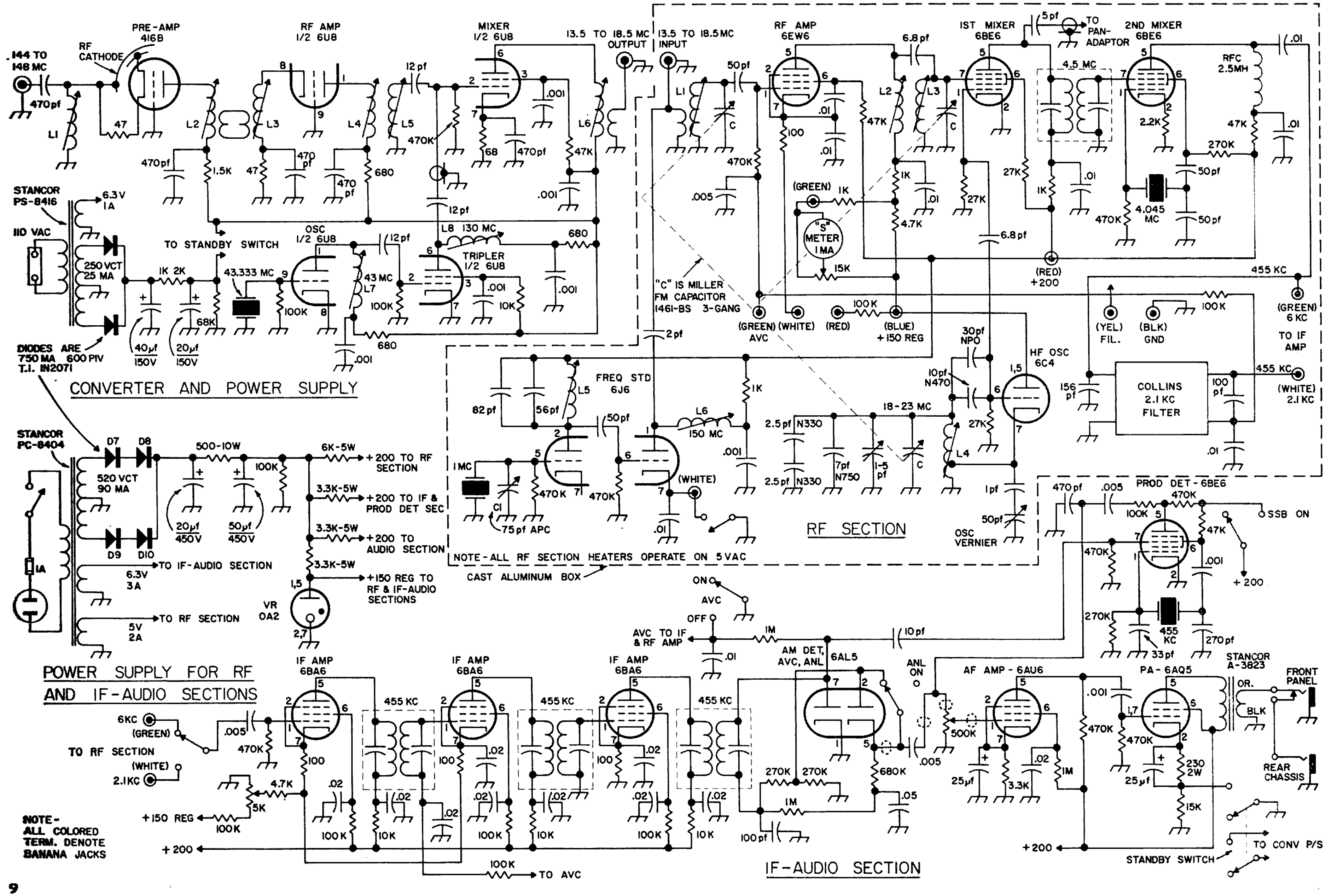
Two meter converter. The converter resembles the Bantam converter described in the first issue of *73* (October 1959.) A 416B preamp has been added for better performance. We didn't use a blower or cathode current meter since the tube is operated at a reduced voltage for maximum tube life. The tube has been

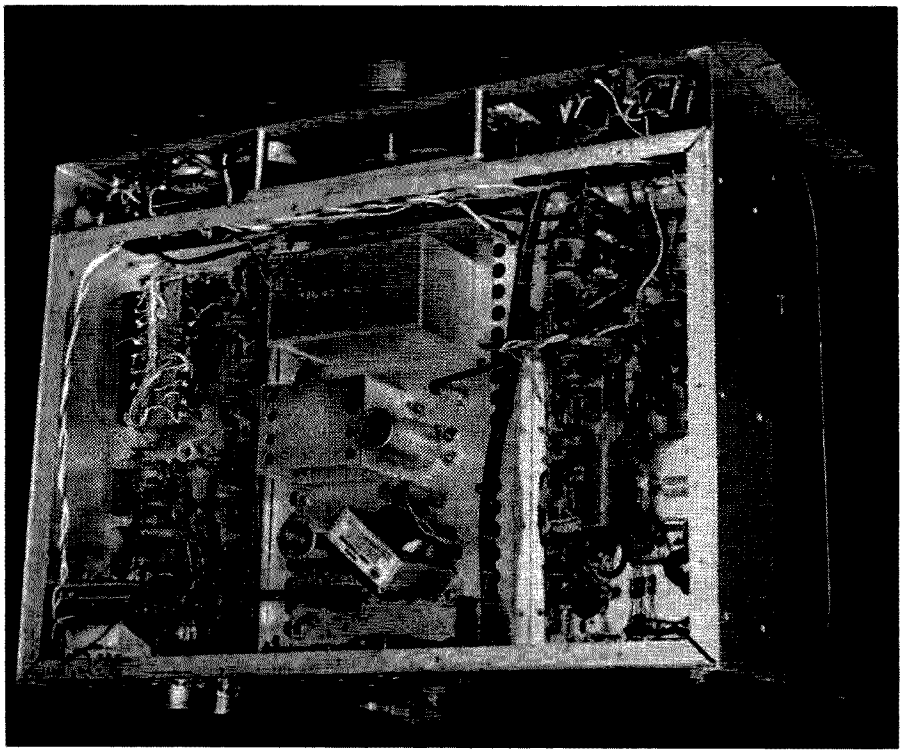


PANADAPTOR

COIL DATA FOR SPACE MONITOR						
COIL	TURNS	WIRE	LENGTH	LINK	TAP	COIL FORM
			CONVERTER			
L1	3	22				MILLER 41A000CBI
L2	7	22 BARE	1/4"	2T		" "
L3	5		SPACE	3T		" "
L4,L5	5	22	SPACE			" "
L6	24	24 ENAM		4T		" 42A000CBI
L7	11	20 ENAM				" "
L8	6	22 BARE				" "
			RF SECTION			
L1	24	22 ENAM		5T		" "
L2	24	22 ENAM				" "
L3	15	22 ENAM				" "
L4	13	22 ENAM			4T	" "
L6	5	22 BARE				" "
L5	10 μh ADJUSTABLE					" 42A105CBI
RFC	2.5 MH					" 640
			PANADAPTOR			
L1	24	24			5T	" 42A000CBI
RFC	10 MH					" 9220-76

ALL 4.5 MC I.F. TRANSFORMERS ARE MILLER NO. 6203
" 455 KC " " " " " 12-C1
" 262 KC " " " " " 12-H1


CONVERTER AND POWER SUPPLY
RF SECTION
IF-AUDIO SECTION
POWER SUPPLY FOR RF AND IF-AUDIO SECTIONS
.144 TO 148 MC
PRE-AMP 416B
RF AMP 1/2 6U8
MIXER 1/2 6U8
OSC 1/2 6U8
TRIPLER 1/2 6U8
13.5 TO 18.5 MC OUTPUT
13.5 TO 18.5 MC INPUT
RF AMP 6EW6
IST MIXER 6BE6
2ND MIXER 6BE6
TO PAN-ADAPTOR
HF OSC 6C4
FREQ STD 6J6
COLLINS 2.1 KC FILTER
PROD DET - 6BE6
AM DET, AVC, ANL 6AL5
IF AMP 6BA6
AF AMP - 6AU6
PA - 6AQ5
STANCOR A-3823
STANDBY SWITCH
TO CONV P/S
STANCOR PS-8416
STANCOR PC-8404
110 VAC
DIODES ARE 750 MA 600 PIV T.I. IN2071
VR OA2
"C" IS MILLER FM CAPACITOR 1461-BS 3-GANG
NOTE - ALL RF SECTION HEATERS OPERATE ON 5 VAC
CAST ALUMINUM BOX
NOTE - ALL COLORED TERM. DENOTE BANANA JACKS



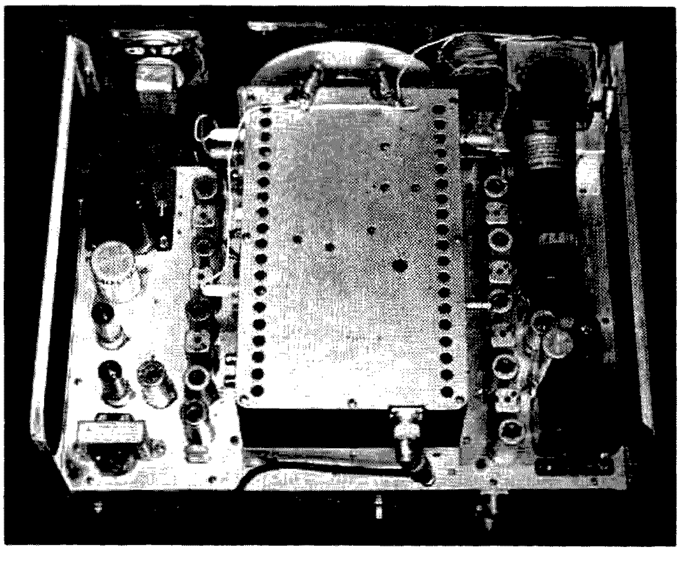
The bottom view shows the placement of the two meter converter over the rf chassis cut-out. RG-58A/U is used to transfer signals to the band switch in the upper right corner.

used for over a year with no decrease in performance. The converter with its power supply was bench tested as a module before securing it in place over the rf section in the cast aluminum box.

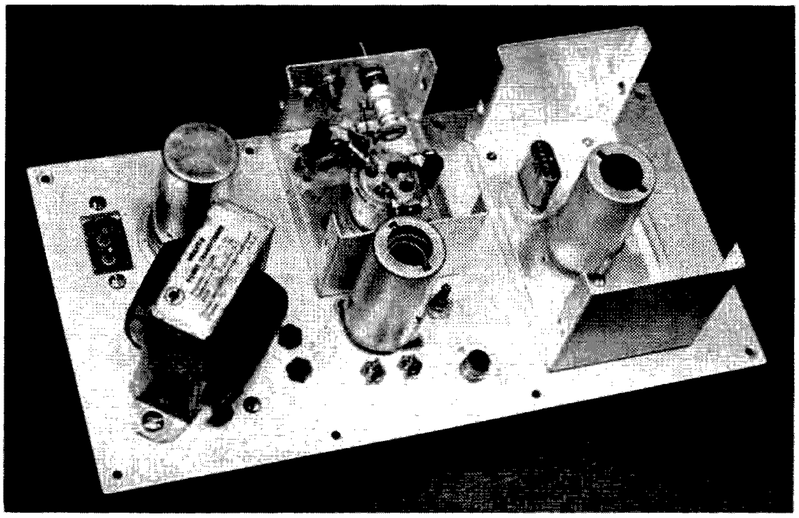
Panadapter. A lot of material has been published concerning the construction and use of panadapters so we won't repeat it. But after using it, we must emphasize that it's a necessity in all good stations. The circuit is similar to previously published ones, but mechanically it differs in that it is very compact. The only critical components are the reactance tube modulator and oscillator tank. We'd suggest that you follow the values and layout there carefully. The maximum sweep is about 260 kc and the pips are very sharp. Two signals 10 kc apart can easily be distinguished. The unit is complete with power supplies, so was easy to bench test before installation. Only vital controls are brought to the front panel.

Main *if* chassis. This consists of an aluminum plate mounted over a cut out provided for it. On this plate is the power supply, audio amplifier, product and AM detectors and a 455 kc *if* strip. The *if* amplifiers were mounted in the usual in-line manner to avoid regeneration. The ANL and audio gain control leads should be shielded.

Product detector. The product detector for SSB and CW reception is energized by a



This top view from the back shows the arrangement of the panadapter at the right of the main rf tuner. The left side of the tuner contains the balance of the receiver.



Top view of the two meter converter showing the Minibox construction of the converter and pre-amp. On the left is the power supply. The center tube is the 6U8 mixer-amplifier. Behind it is the Minibox holding the 416B. The right Minibox contains the 6U8 oscil ator.

switch on the front panel which turns on the B+ for the stages. The BFO uses a 455 kc crystal. The audio output is in parallel with the AM detector to the audio gain control.

Audio amplifier. The audio amplifier is standard. It produces about 2½ watts of audio output. The built-in speaker is plugged into one of the output jacks.

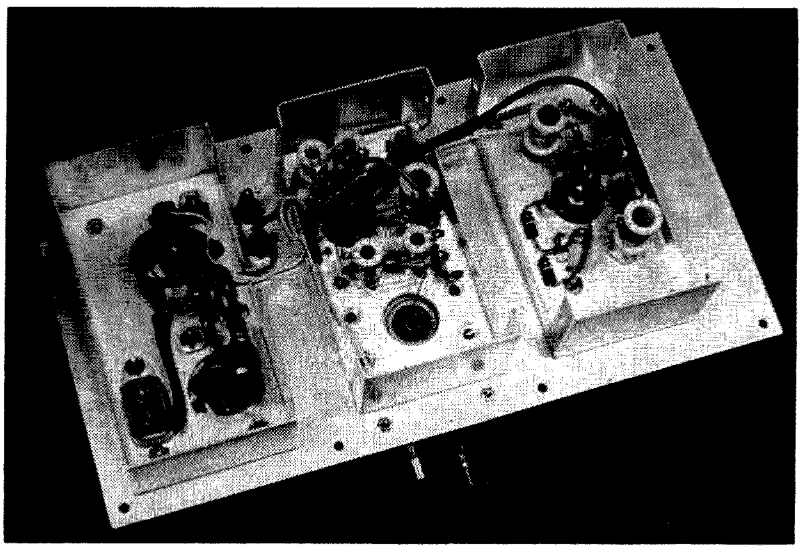
Main chassis. The main chassis is a 17 x 11 x 3 inch chassis. Three holes were cut in its top for the three subassemblies with a half inch strip between the holes.

Front panel. The front panel is a standard 19 x 8-¾ x ⅛ inch gray crackle finish plate. The escutcheon for the dial was cut out of ⅜ inch aluminum plate and fastened to the panel with flat head screws. It is sprayed with black crackle finish and clear plastic. The frame on either side of the escutcheon is made of 1/16 inch aluminum with the same treatment. The dial plate was made by cutting two pieces of 1/16 inch plexiglass with a fly cutter and sandwiching the hand calibrated dial between them. The diameter is about 6 inches. The bezel and shield for the CRT were made by Millen. The S-meter is a 0-1 ma Simpson mounted upside down. The calibrated scale is quite easy to make with Datak letters on a piece of bristol board. The speaker grill came from a portable radio. All control labels are engraved for that professional look.

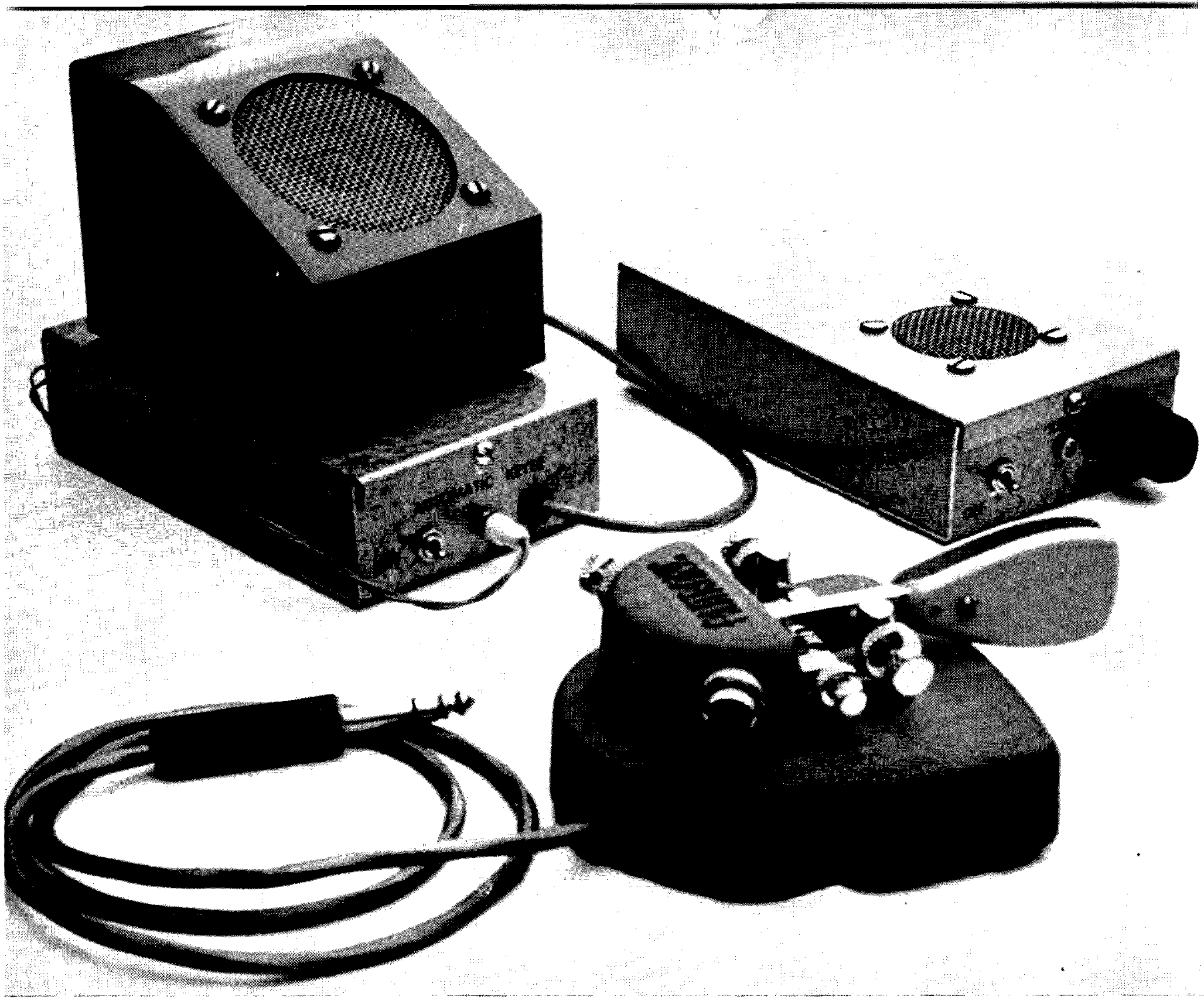
Results

Operating a receiver of this type is really a pleasure. Signals can be spotted on the scope and identified in the various modes and signal strengths. The gradicule on the face not only helps determine the percentage of modulation of the received carrier, but also gives the separation between signals. Those who construct this receiver will find it very worthwhile.

. . . W9DUT, W9JFW



Bottom view of the two meter converter. In the center housing is the 416B pre amplifier and 6U8 socket. Injection to the mixer is through a coaxial line running to the oscillator in the Minibox on the right. The two coil forms in the oscillator section are the oscillator and tripler coils. The compartment on the left is the converter power supply.



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Santa Ana, Calif.

Build a modern automatic keyer for under $20

A Unijunction Keyer for CW

To be sure, several good and easy to construct keyers have appeared in the past. Each has its own particular point of interest. To follow suit with another may be with little justification. However, it is the belief of at least one person that this keyer is different enough to have definite appeal to anyone who prefers compactness, portability and functional completeness in one package.

The popularity of past keyers has been tied up in the designer's definition of the term "automatic." Adjectives, such as fully automatic, semi-automatic, self-completing, dot-memory, etc., are added to help clarify the design intent. It is the intent of this article to describe a low cost keyer that is fully automatic, and self-completing (including the space-after-mark) in a very small package (1⅞" x 3⅛" x 5½"). It contains its own power source, a 9 volt battery, and has a built in sidetone oscillator.

A semiconductor device that is all but unknown among amateurs is put to good use in this circuit. Called the unijunction, it plays the central role in its operation and, thereby, deserves being discussed first.

The circuit of Fig. 1 is an electrical equivalent of the unijunction. RB1 is related inversely to the current in the emitter, and will vary, for a typical unijunction, from several thousand ohms to just tens of ohms, as the emitter current changes from 0 to 50 ma. (For this typical unijunction, RB2 would also be several thousand ohms.)

Let us examine the circuit of **Fig. 2.** While the capacitor is charging, the unijunction has no effect. When the capacitor voltage reaches the threshold, current in the emitter causes RB1 to decrease and thus, for more current to flow. In a very short time, tens of microseconds, the capacitor "dumps" almost all of its charge into the low resistance emitter and soon will no longer supply enough current to the emitter to keep RB1 low. The diode becomes back-biased and the unijunction reverts to its "inactive" state, and the capacitor begins charging again. This is the sawtooth circuit that is used in the keyer. The G.E. *Transistor Manual* carries the discussion of unijunction operation to the next several levels of understanding.

The portion of the circuit consisting of the unijunction and the threshhold switch transistor Q2 actually comprise a basic keyer. Q3 is merely a relay driver and can be, just as well, the keying switch, to connect directly to a transmitter, with a properly chosen transistor. However, no attempt was made to find and try such a transistor since the relay circuit worked more than adequately and is much less restricted.

Fig. 3 has been provided to explain the operation of the keyer. The voltage across capacitor C1 is the most prominent waveform shown.

The self-completing characteristic is attributed to the fact that once the capacitor is discharged, (at t_1 or t_4) the key has no effect until the voltage rises above the firing point of the unijunction (at t_3 or t_5, respectively. This way, a mark or "on" condition and a space or "off" condition of standard length must be completed before any subsequent mark can be initiated.

The photograph shows two different stages in the evolution of the keyer. The unit on the left originally had the key wired permanently to it. The resulting key-keyer combination was still not obtrusive (after all, the key was not likely to be needed elsewhere.) However, the

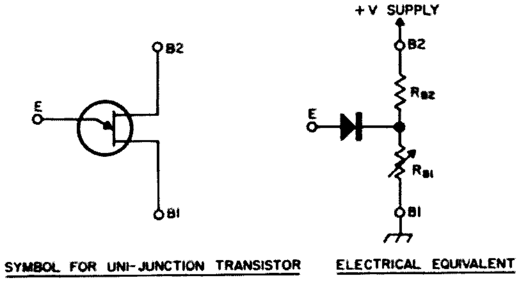


Fig. 1. Symbol for the unijunction capacitor and its electrical equivalent.

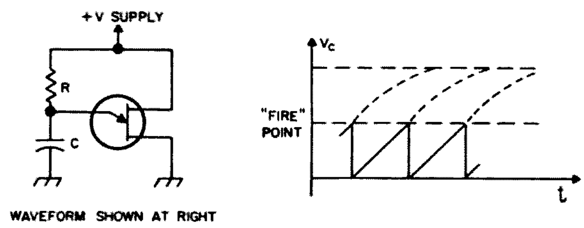


Fig. 2. Action of the unijunction oscillator.

desire for a built-in oscillator to monitor the output and a few design experiments prompted the building of the second unit with the requirement that the key disconnect from either unit. The speaker grille is visible along with a "speed control" knob. The original unit has trim-pot screwdriver adjustments. The meter case contains an outboard oscillator for keyer number one.

The finished unit draws less than 3 ma of current in standby and less than 10 ma with continuous marks (continuous dashes draw more than continuous dots.) It does not appear economical to use the "bargain" 30 cent battery that seems to be available most everywhere, even though they will probably last several weeks, depending on usage. This may be due to the fact that the relay can operate erratically if the battery voltage drops very much below 9 volts. It is rated to pull in at about 7 volts, although it can be mechanically adjusted for minimum spring tension.

In order to evade a perfectly good question, the price of building this unit will fall somewhere in the range of 8 to 38 dollars, from one who requires only the semi-conductors, the relay and case to one who buys all brand new sub-miniature components and a printed circuit kit. The average cost should, however, be

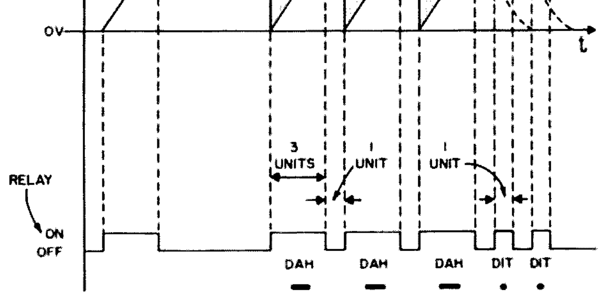
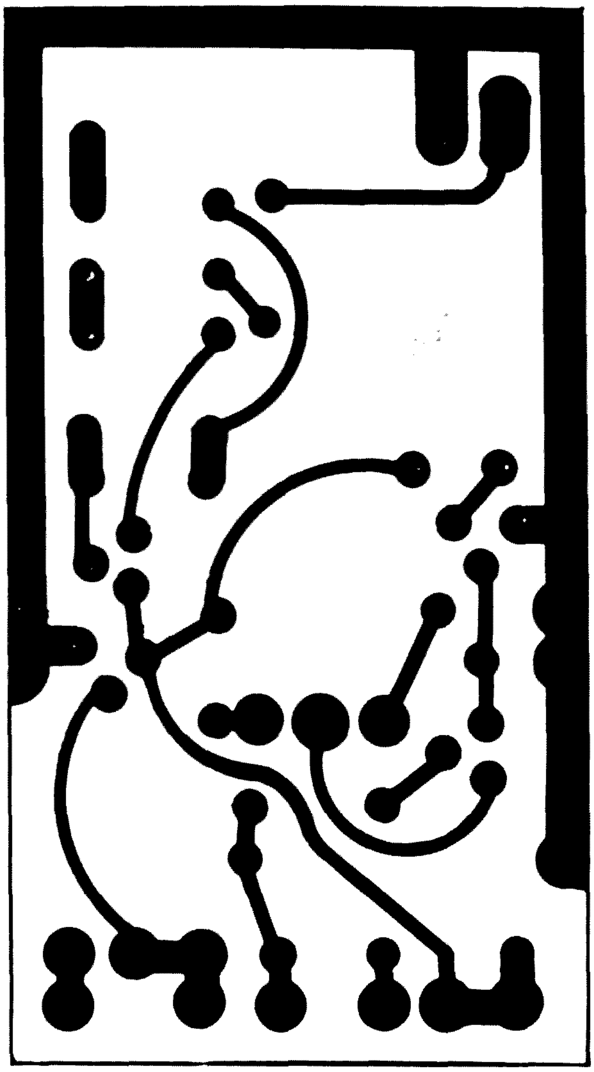
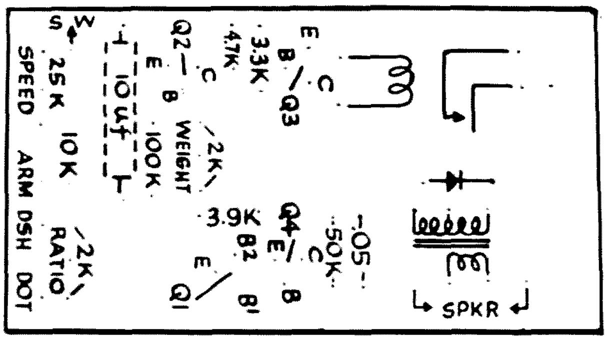


Fig. 3. Operation of the keyer.



Here's a full size layout of the Harris printed circuit board for the keyer. Note that the circuit has been modified slightly to eliminate the extra 1.5 v battery. The component side of the board is shown reduced below.



The easiest way to build this keyer is with the pc board from the Harris Company. The board is 2-3/4" x 5" and everything but the speaker and key jack fits on it. An ideal case is the inexpensive Bud 3006. The board comes with all **65** holes drilled and included with each board is a detailed instruction sheet and picture of parts layout as well as a list of the best parts to use and their source. You can build the complete keyer from all new parts with this circuit board for $18.50. The board is $4.50 or you can buy it with the transistors already mounted for $8.95. Write the Harris Company, 56 E, Main, Torrington, Conn.

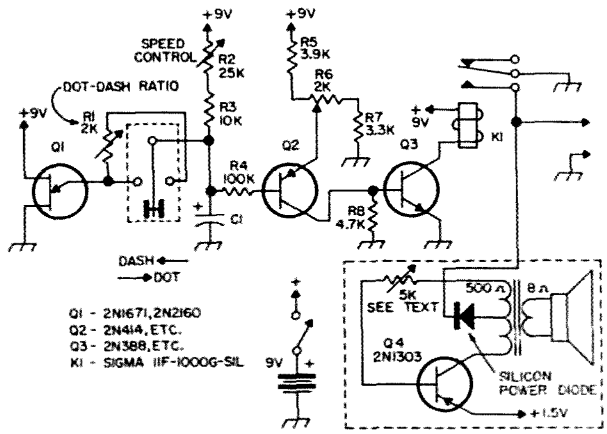


Fig. 4. The Unijunction Keyer for CW. Q2 can be relatively high beta (over 50) PNP transistor. Q3 is any NPN transistor. K1 is a Sigma 11F-1000G-SIL ($1.75).

somewhat less than the arithmetic average. Vague enough?!

The schematic (**Fig.** 4) shows, for the oscillator-monitor, the "CW Monitor" described in **73** on page 44, June '63 by WA2WFW. As a note of caution, however, an extra 1.5 v supply is recommended, as shown, since the power requirements for the oscillator are high enough to drastically load the 9 volt battery if used with a divider or zener diode supply to power it.

The values of R2 and R3 shown in the schematic are sufficient to provide a speed range of approximately 10 to 40 wpm, judged to be the most popular range among those who count.

R5, R6 and R7 are used to provide the resolution needed if a standard potentiometer (1 turn) is used. If a 15 turn, screwdriver adjust, trim-pot (Bourns type 3067, 10K-ohms, $1.65) is used, R5 and R7 are not needed.

It is strongly advised that adjustment be accomplished through the use of the meter method or any scheme that utilizes quantitative measurements and not to do it by ear. The difference would be readily apparent if one adjusted by ear first and then with a meter.

The meter method utilizes the fact that a dc meter will integrate a rapidly repetitive waveform to display the average value. A voltmeter is connected, through the relay, to any battery. Holding the key in the "dash" position, adjust the weight control until the meter reads ¾ of the battery voltage, connected through the relay contacts. Then holding the key in the "dot" position, adjust the dot-dash ratio control until the meter reads ½ of the battery voltage, connected through the relay contacts. Recheck the first adjustment. This completes the procedure. . . . WA6TSA

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Two-Element Twenty-Meter Vertical Array

Here's a twenty-meter antenna that should, in theory, radiate a horizontal pattern similar to that shown in **Fig. 1**. The pattern is, of course, subject to being affected by nearby metallic objects, but from my own crude checks with a non-calibrated field intensity meter, and in QSO's, the actual pattern seems to approximate the theoretical. The vertical angle of radiation is quite low.

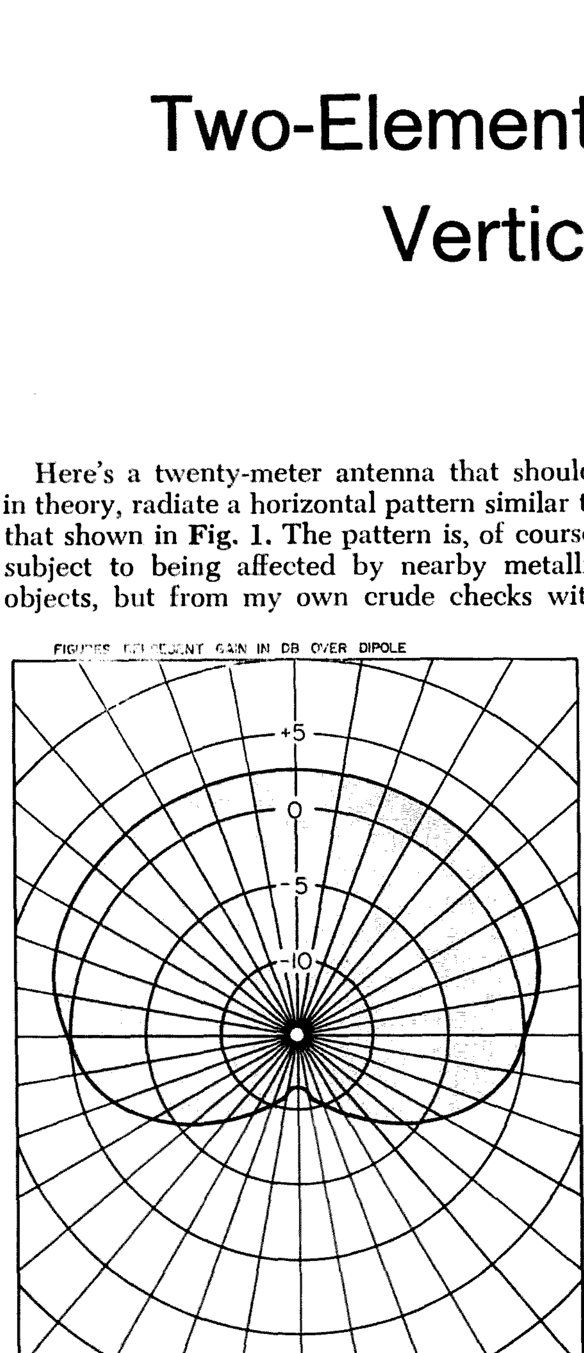


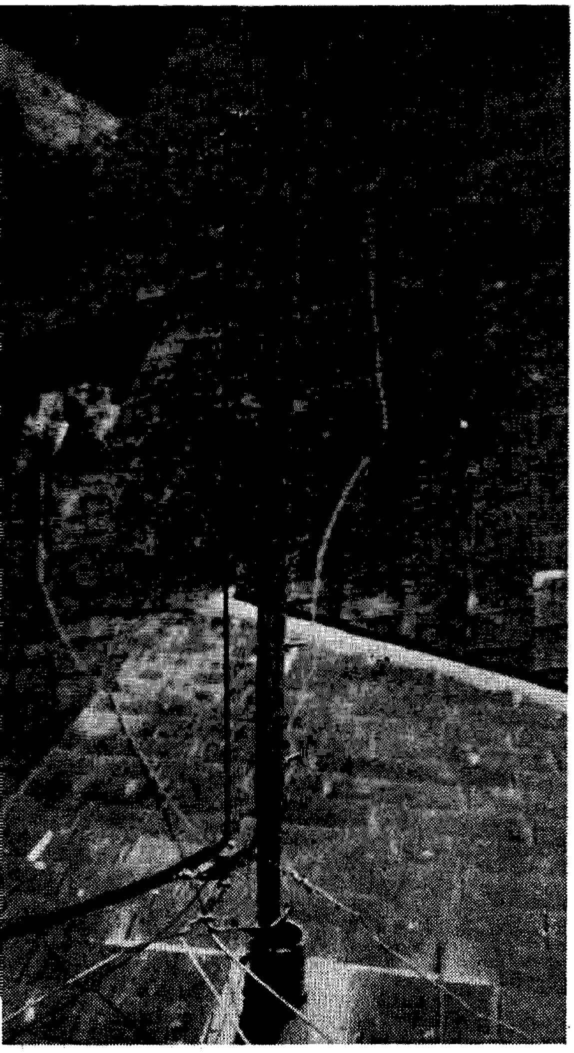
Fig. 1. Gain pattern of ground plane vertical antenna with reflector spaced 0.2 wavelength from the radiator.

An array of this type has a forward gain of approximately three db, and a front-to-back ratio of 15 db. I chose this particular antenna after concluding that a full-sized twenty-meter beam would dwarf my house and make it appear as though a large bird were hovering over it. And the asthetic aspects of a quad were something less than thrilling to my wife.

Since I had used a ground plane for a few months with fair luck on twenty meter **RTTY**, adding a reflector to the ground plane seemed to be a natural step. Of course, an obvious limitation to this type of array is that it is non-rotatable and you have to decide, before putting it up, in which direction to point it. My array, according to my Woolworth compass, is pointed across the center of the United States.

A schematic of the antenna array is shown in **Fig. 2**.

The VSWR of the ground plane alone, fed with RG-8/U 52-ohm coaxial cable, was about 1.2:1 and went up to over 1.5:1 with the addition of the reflector. The VSWR was lowered to 1:1, as shown in **Fig. 3**, by the addition of a gamma-match feed arrangement and by using eight drooping radials for the ground plane. Four of the radials, for which #12 copper wire was used, are slightly longer than a quarter wavelength at 14.1 mc and four are slightly shorter.



se of the ground plane radiator showing gamma
ıtch arrangement.

One of the radials is attached to the bottom the reflector element. Spacing of the radia- (ground plane) and reflector is 12 feet, or out 0.2 wavelength. The radiator is 16 ft 6 long and the reflector is 17 ft 9 in long.

Matching is accomplished by tapping the mma match up approximately two feet from bottom of the ground plane, and then mak- careful adjustments up or down in incre- nts of an inch or so, until minimum re- cted power is indicated. Pruning the radials, d adjusting their droop, then follows. This ocedure should enable you to obtain a WR as shown in **Fig. 1.**

Both the radiator and reflector are made aluminum tubing. The sections of the alumi- m tubing are connected by forcing a length dowel into one section, securing with a ew, and then forcing the other section over length of dowel extending from the first ction. The sections are connected electrically drilling through the aluminum and dowel,

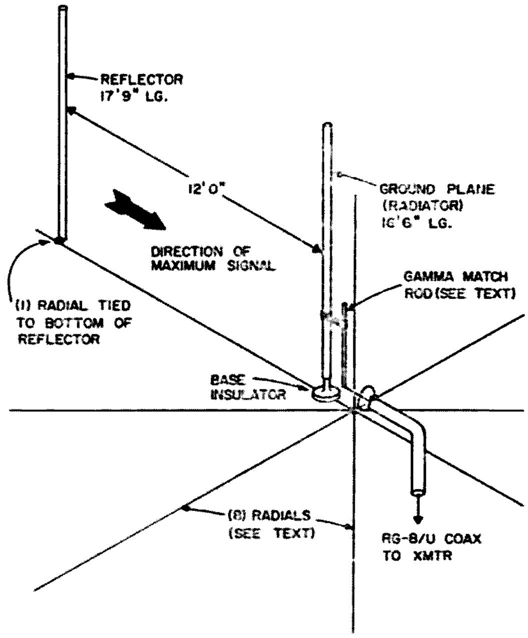


Fig. 2. Schematic of the antenna array.

on both sides of the joint, attaching screws, solder lugs and nuts, and soldering short pieces of #12 wire between the sections.

The top few inches of both the ground plane and reflector are made of ½-inch soft aluminum tubing, so that if pruning of the elements is necessary to an exact frequency it can be easily accomplished. A short length of dowel is forced into each of the tops of the elements (in the large diameter tubing) to prevent them from filling with water.

The radiator and reflector are guyed using egg insulators and plastic clothes line. A piece of phenolic rod of the same diameter as the inside diameter of the tubing is used as the base insulator of the radiator. The reflector is supported by a length of dowel, which is adequate insulation for this element, as the radials are merely laid on the roof and since the reflector is attached to one of the radials, an insulator at the base of the reflector would serve no useful purpose.

. . . W6TKA

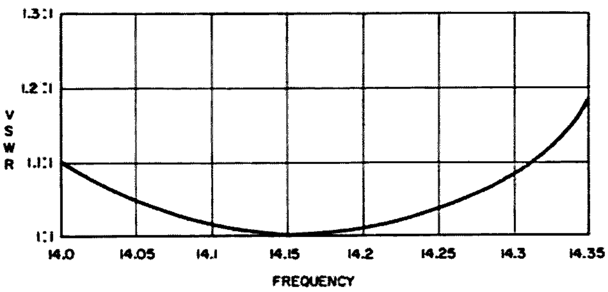


Fig. 3. VSWR vs frequency, ground plane with reflector.

They Said It Couldn't Be Done

"What? A female build a rig?" "You're nuts!" These were the comments I used to hear when I announced my plans. After months of constant ribbing about the subject, I decided to do something about it. Just where do you start, presuming you have never so much as tightened a screw on a chassis?

After building up my confidence, I set out to receive the aid of my husband to be, a die-hard home-brewer. His comments all amounted to: Surė I'll help you, provided you do all the work!

The beginning started with the help of his library of ham reference books. After boning up on various subjects, I was ready to be acquainted with the common everyday ham tools. I was shown how to use these *once*—then I was on my own. I soon learned that a valuable part of any hamshack is the junkbox. Using a small breadboard of perforated aluminum and various otherwise useless components, I learned the art of soldering, fastening screws, working with wires, and drilling holes. (How I hated to use that electric drill!) Once I had acquired the use of the equipment, I had to decide just what I would build. I didn't want anything too complicated; yet it had to be an accomplishment for me—something to be proud of. After studying several schematics I came up with the idea of building a low power six meter cw rig. It would be easier than building an AM rig, and yet it would be challenging.

Back to his junkbox I went to collect some of my parts; the others I managed, somehow, to get from other friends. After weeks of collecting my parts, and tools, I soon had a blank look on my face. (How should I begin?) With

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Illustrations by Wayne Pierce K3SUK

some advice from the OM-to-be, we planned how I would arrange the parts. No one would ever believe that it might have taken me a half hour to figure out where to make a connection. Weeks, months, and seasons went by before the "VHF Special" was completed. The surprising part was that after I finished it, it tested out to work the first time. I was on the air! But more important, I had done it myself. You can too, why not try it.

Before you change your mind and start thinking up excuses to tell yourself, hear me out! Let us assume that you are a new "green" ham. You just passed your test, have your license framed in full view and are anxious to get on the air. You say to yourself "sure it's easy if you've got someone to help you design a rig and furnish parts, but what about me?" My reply would be to equip your hamshack with useful inexpensive reference material such as the magazine you are now reading. By reading various types of articles, you will be able to pick up many helpful hints and ideas to use. Handbooks, magazines, and pamphlets all contain descriptions of easy to build equipment.

Join your local radio club. Discuss your ideas with other hams. Ham's are very friendly people. You will probably meet someone in your own situation or someone who might be eager to help you.

There are some basic necessities which you will need for constructing your project. Take some of that "green stuff" out of your pocket and invest in a good set of tools. Screw drivers, long-nose pliers, diagonal cutters, a drill, a soldering iron, solder and an assortment of basic hardware are all essential for building. Anyone will tell you that inexpenive tools never last and are no bargain, so don't be afraid to spend a little extra to get quality tools.

Review your reference material and decide what you want to build. It might be a rig that has already been built or one you design, using parts of various schematics. Don't quit even if you think you just can't go on any further. The worst that can happen is that you'll swallow your pride and have to ask your fellow hams a question. No doubt, they'll only tell you once—so pay attention.

Make up your mind that you will succeed, and stick with it until you get it working. Don't be afraid to learn from your mistakes. Remember, the only difference between a successful builder and a failure is that the successful builder didn't quit when he came up against a problem. You, too, can be a successful builder!

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Simplified RF Impedance and Power Measurements

Jim Fisk WA6BS

Of all the measurements that are made, the accurate determination of radio-frequency power and impedance present the most difficulty, particularly at frequencies above 100 mc. Many methods have been developed over the years for highly exact power and impedance measurements, but the majority of these techniques require accurately calibrated precision instruments. One method that has apparently been overlooked by most writers is the simple procedure presented here.

DB Loss	Power Ratio	DB Loss	Power Ratio	DB Loss	Power Ratio
0	1.000	2.5	.562	5.0	.316
.1	.977	2.6	.550	5.1	.309
.2	.955	2.7	.537	5.2	.302
.3	.933	2.8	.525	5.3	.295
.4	.912	2.9	.513	5.4	.288
.5	.891	3.0	.501	5.5	.282
.6	.871	3.1	.490	5.6	.276
.7	.851	3.2	.479	5.7	.269
.8	.832	3.3	.468	5.8	.263
.9	.813	3.4	.457	5.9	.257
1.0	.794	3.5	.447	6.0	.251
1.1	.776	3.6	.437	6.2	.240
1.2	.758	3.7	.427	6.4	.229
1.3	.741	3.8	.417	6.6	.218
1.4	.725	3.9	.407	6.8	.209
1.5	.708	4.0	.398	7.0	.200
1.6	.692	4.1	.389	7.25	.188
1.7	.676	4.2	.380	7.50	.178
1.8	.661	4.3	.371	7.75	.167
1.9	.646	4.4	.363	8.0	.158
2.0	.631	4.5	.355	8.5	.141
2.1	.617	4.6	.347	9.0	.129
2.2	.603	4.7	.339	9.5	.112
2.3	.589	4.8	.331	10.0	.100
2.4	.576	4.9	.324	20.0	.010

Table 1. DB loss versus power ratio.

Although many radio handbooks advoca the use of an RF ammeter and the I^2R fo mula to determine power into an antenna, th method is usually not very satisfactory. If tl standing wave ratio is greater than unity, tl current is a function of ammeter location alo the transmission line and the application I^2R simply aggravates the error. The use an RF voltmeter and the E^2/R equation pr sents the same problem.

Most commercial power measuring instr ments use calorimetric techniques, whe power is determined by measurements of ten perature, mass and time. Other instrumen use balanced resistance bridges, direction couplers and current across a calibrated loa The convenience of direct measurements co money however and instrumentation of th type is prohibitively expensive.

The accurate measurement of RF impe ance presents many of the same vagaries power measurements. Commercial impedanc bridges are available that will measure com plex impedance directly, but again, are quit expensive.

It has been previously noted that wh power is supplied to a load that is not matche to the transmission line, the current and vo age distribution along the line must be know to accurately determine power. This voltag distribution may be determined if the stan ing wave ratio and the voltage at some a cessible point along the line is known. How ever, the application of this procedure r quires the use of a slotted line. At microwa

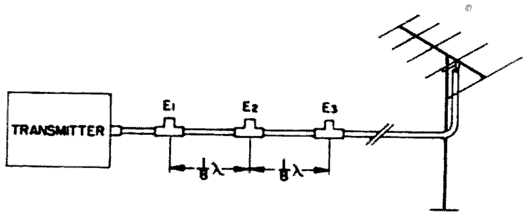


Fig. 1. Setup for measuring transmitter power.

frequencies the slotted line lends itself to both power and impedance measurements, but the associated arithmetic is nearly insurmountable. Furthermore, the slotted line becomes quite a massive structure at frequencies below 500 mc.

A fixed frequency adaptation of the slotted line technique which requires no sophisticated instrumentation was developed a number of years ago* but apparently it is not widely known. This technique, which uses three RF voltmeters spaced one-eighth wavelength apart along the transmission line, is adaptable to any of the amateur bands up to 1296 mc. In this method three coaxial tee connectors are installed one-eighth of a wavelength apart as shown in **Fig. 1**. The necessary one-eighth wavelength dimensions for the various amateur bands between 10 meters and 1296 mc using RG-8/AU type coaxial cable is listed in **Table I**. The length of transmission line from the last tee connector to the antenna may be any length that is suitable for your particular installation.

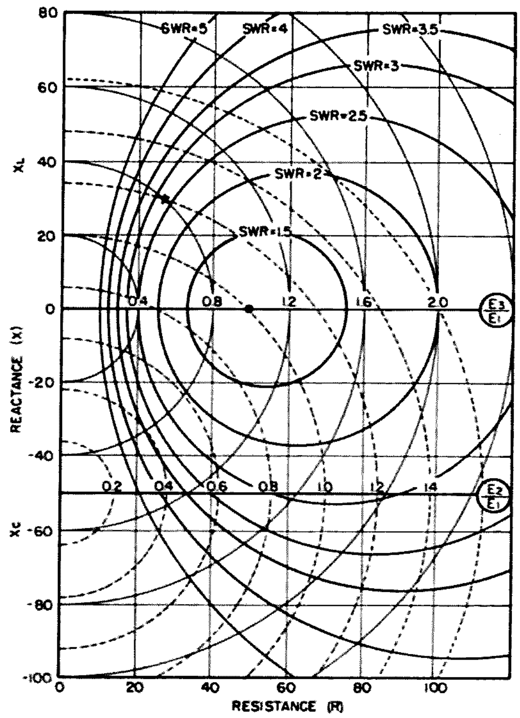


Fig. 2. RF power, SWR and impedance chart.

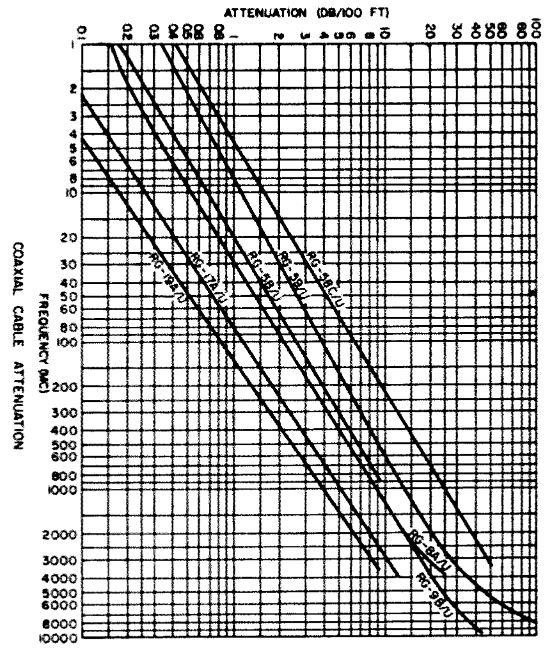


Fig. 3. Line loss versus frequency in coax cable.

Using a volt-ohmmeter or a VTVM with a suitable RF probe, the voltage is measured at each of the tee connectors. The voltmeter may be calibrated satisfactorily at 60 cycles because any errors due to frequency will cancel out in the process of calculation. Each of the measured voltages is indicated by E1, E2 or E3 according to the measurement point indicated in **Fig. 1**. The ratio of E2 and E3 to E1 is then used in conjunction with the chart in **Fig. 2** to determine complex impedance, SWR and RF power.

The use of these ratios is best illustrated by a typical example. Assume that at 50 mc the following voltages are measured: E1 = 30 volts; E2 = 36 volts; and E3 = 24 volts. Using these voltages, compute the ratios between E1 and E3, and E1 and E2 as follows:

$$\frac{E3}{E1} = \frac{24}{30} = 0.8 \qquad \frac{E2}{E1} = \frac{36}{30} = 1.2$$

These ratios determine which circles are to be used on the chart; in this case the E3/E1 = 0.8 curve intersects the E2/E1 = 1.2 curve at the point indicated on the chart by the small star. The impedance at connector E3 may be read directly from the chart as indicated by the intersection of the two curves. In this case the impedance is 27 ohms resistive and 31 ohms reactive (inductive) at connector E3. This corresponds to an SWR of approximately 2.75 to 1 as indicated on the chart.

* An adaptation of the three voltmeter method for measuring power and voltage at high frequencies, Research Labs., Elect. and Musical Industries, Ltd. (1941).

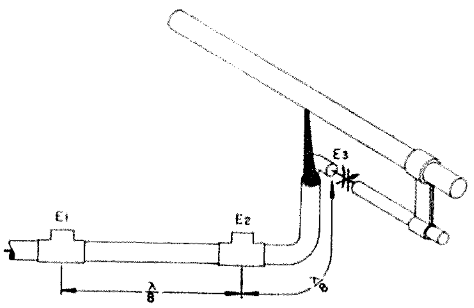


Fig. 4. Antenna matching.

The RF power in the transmission line at connector E3 may be calculated by the following relation:

$$\text{RF Power} = \frac{E_3^2\ R}{R^2 + X^2}\ \text{Watts}$$

From the previous example at 50 mc, the RF power may be calculated by

$$\text{RF Power} = \frac{24^2 \times 27}{27^2 \times 31^2} = 9.2\ \text{Watts}$$

It must be remembered that this is the power at that particular point on the line. The actual power arriving at the antenna will be somewhat less than this depending upon the SWR and line loss at the operating frequency.

The line loss versus frequency of various common coaxial cables is illustrated in **Fig. 3.** At 50 mc, assuming RG-8/U cable, the loss is 1.4 db per 100 feet. From Table **I**, 1.4 db corresponds to a power ratio of 0.725. In other words, if 100 feet of RG-8/U is used in our example, 0.725 × 9.2 watts or about 6.7 watts will reach the antenna.

The standing wave ratio found using this approach is the ratio at connector E3 and must be slightly adjusted to determine the actual SWR at the antenna. This is because the attenuation of the transmission line will make the SWR appear better than it actually is. The procedure for plugging in the necessary correction factors has been covered in a previous issue of "73".**

In addition to determining SWR, impedance and power at the transmitter end of the line, this method is also applicable for tuning antennas. In this case it has several definite advantages over SWR bridge or antennascope type measurements. This is because this method immediately indicates whether an antenna is inductively or capacitively reactive. The other methods show that the antenna is reactive, but not what kind or how much! When tuning a gamma match the advantages become quite apparent; any inductive or capacitive reactance of the antenna may be immediately tuned out and a good match obtained. Since an exact match is indicated when the voltages at each of the three tee connectors is the same, the setup shown in **Fig. 4** is more oriented toward antenna matching than that illustrated in **Fig. 1.** Antenna matching may be accomplished faster if three voltmeters are used, but it is not absolutely necessary.

One other advantage of this system is that the tee connectors may be left in the line at all times with no noticeable degradation to the radiated signal. There will be slight losses on 432 mc and up, but usually they will be negligible.

This method has been checked against commercial power and impedance measuring equipment and found to be very accurate. The only source of inaccuracy appears to be in the length of the eighth-wavelength lines; these must be precisely the right length at the operating frequency or rather large errors will be evident. However, considering the overall simplicity of this approach, this criticality in line length is really quite minor.

. . . WA6BSO

** That Elusive SWR, WA6BSO, "73", December, 1964.

Lorry Levy WA2INM/1
Marlboro, Vermont

Get ready now for that Springtime mountain-topping!

A Six Meter Solid State Peanut Whistle

I've always wanted to own a walkie-talkie. You know, one of those little black box type gadgets with a whip antenna sticking out on the top, complete with ham frantically trying to climb on top of anything around to get height, while working a group of local stations. They can be found at most transmitter hunts. I've always felt that they have had an unfair advantage at hunts. This is usually at the time when I have reached the general area of the hidden transmitter, along with several others, and one of the hams, carrying one of those black boxes, starts searching all the good hiding places while I either have to stay in the car or miss out on what is going on while looking. Bah!

I decided to build one so that I too could get in on the fun. Tubes were out, after a quick look at the prices of batteries. Transistors are cheap, draw little current from cheap low voltage batteries, and are vastly more reliable. The receiver had to be a superhet to get the desired selectivity. The transmitter didn't need much power, so that a simple transistor overtone oscillator, driving a class C final, was enough. The power output is about 300 mw. The modulator uses three transistors and has more than enough gain to use a crystal or ceramic mike.

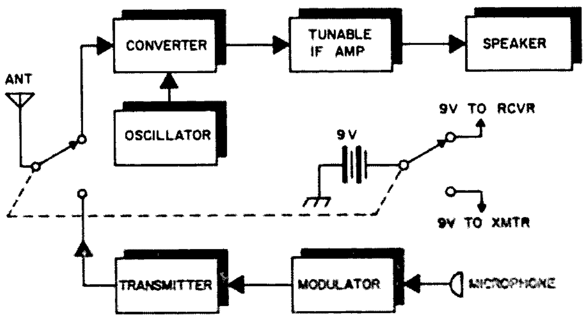


Fig. 1. Block diagram of the 6 meter transceiver.

The receiver is a double conversion superhet, with the first conversion crystal controlled, and using one of those Japanese six transistor portable radios for the second *if* and tunable oscillator. The use of the radio saves considerable time and money in the construction of a receiver. They have fairly good selectivity and sensitivity, an audio section, tunable oscillator, and some of them even have a tuned rf stage. The price of the parts to build one of them is considerably more than the cost of the assembled radio. They can be purchased new for about five dollars for a six transistor radio. This is just slightly more than the cost of the transistors needed to build one. Sometimes it is possible to pick up one with a damaged case for less money.

The converter uses three transistors. It has a tuned rf stage, an oscillator, and a mixer. The sensitivity of the overall receiver is better than one microvolt for a usable s/n ratio. The selectivity is about 10 kc at the 6 db points. While this is not the spectacular mechanical filter type selectivity that some people would like, it is quite a bit better than any superregen, and about as sharp as practical in a hand carried rig with a 1:1 tuning ratio. The tuning is sharp, but not so sharp that a station can't be tuned in with ease, provided that a fairly large diameter tuning knob is used.

The entire transceiver is powered by a single 9 volt battery, Eveready #2356 or equivalent. If space permits, six D cells will work. If you go hilltopping much, or are in an area where special purpose batteries are hard to come by, it may be better to use the flashlight batteries. At least you can get replacements easily. The Eveready #2356 or the flashlight batteries will work the receiver for several hundred hours if the transmissions are of a reasonable duration.

The rig can be built into a medium sized Minibox or any case that is handy. The one that I built was put into a case from one of the surplus "Gold Plated Specials" that have been available for several years at a reasonable price. There is enough spare room in the case for batteries, the rig and a recharger, if rechargable types are used.

Construction details

The easiest method of wiring, in general, is through the use of perforated boards with push-in terminals. Lafayette Radio sells boards made by Vector for reasonable prices, as well as the push-in terminals. A board 17" x 1³⁄₁₆" can be cut up to make all of the necessary boards for the transceiver and still have enough left over for several other projects. The board is cheap ($1.25).

The converter (**Fig. 2**) can be made on a board less than 3"x4", if care is paid to layout. The layout is non-critical with the exception that the oscillator should be kept away from the rf stage to reduce the possibility of spurious responses and images. By wiring both sides of the board, much space can be saved. The coils should be on the side of the board away from the chassis to avoid detuning when placed in the case. If space is at a premium, the miniature ¼" coil forms can be used but the number of turns will have to be raised to about nine or ten and taps adjusted in the same ratio.

The transistors may be soldered in to the circuit if care is used not to overheat the transistor. A pair of long-nose pliers make an excellent heat sink. Tin the lead with a drop of solder, leave a small blob of solder on the junction to be soldered, and quickly melt the two blobs of solder together with a soldering gun or iron. This is the best method of soldering transistors, and is preferred to the conventional method of heating the entire joint to the melting point of solder and then applying solder, as the transistor is much cooler. I have soldered hundreds of semiconductor devices in this way without damage. If care is taken

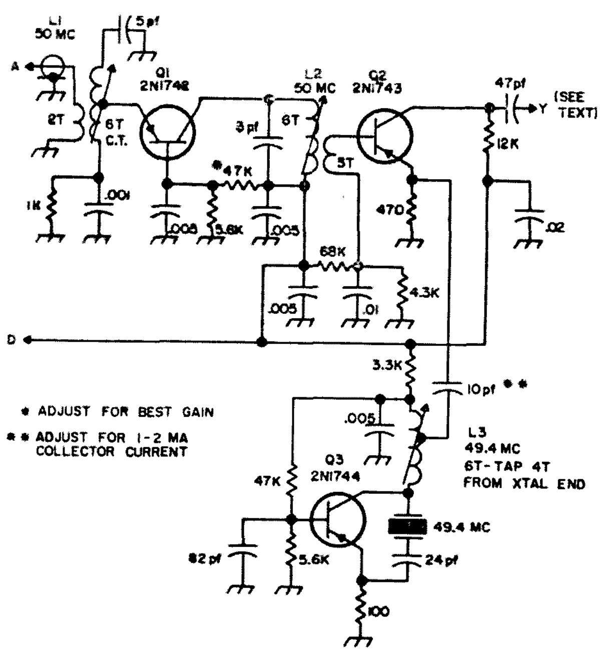


Fig. 2. Schematic of the 6 meter converter. Coils are on ⅜" slug tuned forms.

to melt the solder, and if low melting solder (60/40 or 63/37) is used, it results in a good joint. Caution must be used not to make a cold-solder joint which can cause intermittents and related problems. More caution must be used not to melt the transistor as well as the solder. With a little practice (Use a ¼" resistor and practice making a few joints. You should be able to hold the lead ½" away from the joint without burning your finger. Best method for testing heat transfer to semiconductor device. A slightly warm finger can be cheaper than a ruined vhf transistor) you should be able to quickly solder transistors into the circuit without making a cold joint or overheating anything. Soldering is preferred to sockets in portable devices that may be subjected to a few jolts. They don't fall out of their sockets or cause intermittents due to poor contact if they are soldered.

The xtal used is a 49.4 mc third overtone type, available from any of the crystal companies.

There are many good transistors that will work in the converter. The Philco types are excellent, but a little expensive. I have found a good source of inexpensive transistors that work almost as well. The Sprague RT-82, which sells for about 60¢, seems to work as well as the more expensive types. It is an excellent general purpose vhf transistor and has countless uses in converters, transmitters, and If amplifiers. See also the list in Nov. 73, page 34. Transistors Unlimited, 462 Jericho Turnpike, Mineola, New York, is an excellent source

of new transistors, diodes, tantilum and electrolytic condensers, transformers, rf chokes, and many other parts at unbeatable prices. All of their merchandise is top quality and the prices are CHEAP! In a comparison check, six RT82's, chosen at random, were compared with a Philco 2N1742 as the rf amplifier in the converter. All of them worked as well, and there was no apparent difference in nf. Any weak station that could be copied with the 2N1742 could be copied equally as well with the RT82. A great deal for 60¢. In the final design, three RT82's were used in the converter. The other types mentioned were tried, most of them worked just as well, none worked better, all cost more. Design was based on the PxC equation, the transistors with the highest P (performance) with the lowest C (cost) were used, in keeping with the traditional ham design for the last fifty years.

Point Y (output, is connected to the BC receiver at the hot end of the variable condenser tuning the antenna coil. This seems to work the best of any place tried.

The transmitter **(Fig. 3)** uses a RT82 as the oscillator, driving a 2N1143 as the final. The crystals used are third overtone type. There are no special layout problems. Just keep the output away from the oscillator and there should be no problems.

The modulator can be built on the same board as the final. The general purpose audio transistors are the microphone preamp driving an audio output type transistor found in most portable radios. A 2N188A or GE-2 will work fine. The final is collector modulated through an autotransformer. I used a driver transformer with a 2000 ohm CT winding, applying the battery voltage to the center tap, and connecting the collector of the output transistor to one

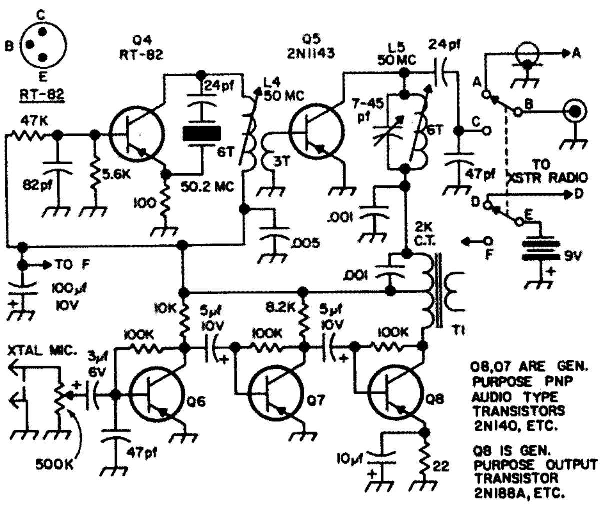


Fig. 3. The transmitter, modulator and basing of the RT-82's. Coils are ⅜" slug tuned forms.

end of the winding and the collector of the modulator transistor to the other end. I did not have to modulate the driver, as I have read somewhere is necessary, to get good, clean modulation, sounding pretty close to 100%. I don't know if the impedances are perfect, but, as long as it works ok, who cares?? (I can just visualize some Electronics Engineer reading that last statement, calculating the necessary impedances, and start tearing his hair out when he sees the mismatch. At any rate, it works fine).

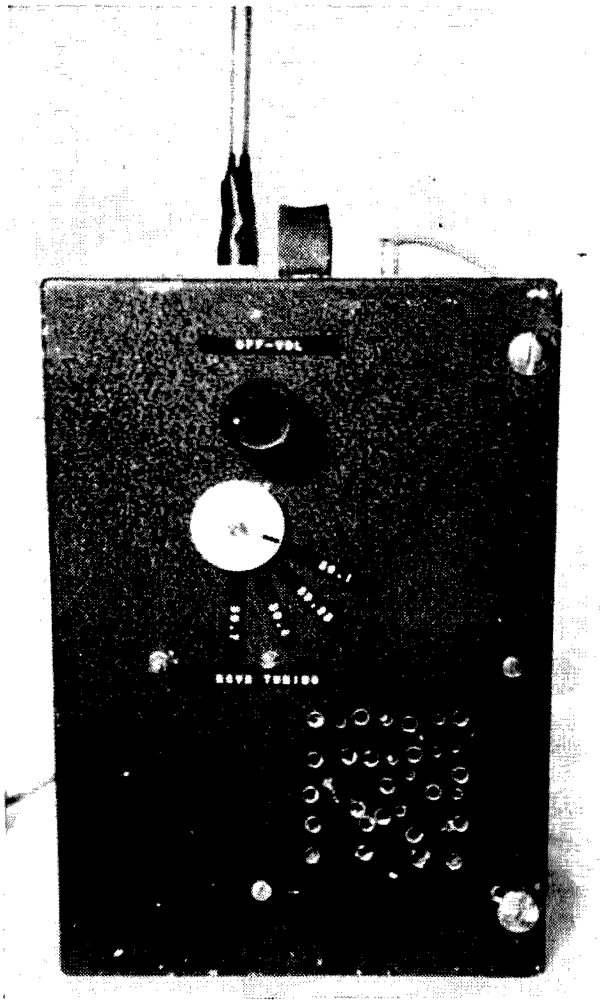
The completed boards are mounted into the case with machine screw type standoffs, three or four being all that is necessary to mount each board. The transistor radio should be of the type that has the tuning condenser coming out to the front panel with a directly driven shaft. Ones with dial cords are a problem to mount. The radio is removed from the case and the knobs are removed. The speaker leads should be removed from the speaker that is left in the case. The leads should then be removed and replaced with longer leads from the pc board to the new speaker. A 4" speaker works better than the ones that are usually supplied with the radios. It is preferable that the radio used have a positive ground (it should also be the type that uses a 9v battery for power) as it simplifies construction. The majority of the Japanese 6 transistor portables are 9v positive ground, but it should be checked anyway. If the radio is of the type that uses a volume control mounted on the back of the pc board, meant to be used with a knob that protrudes from the side of the radio, remove the control from the board, jump the switch connections, bring out three leads and replace it with one of the dime sized controls that mounts on the panel of the transceiver. A 10K type with a switch should work for most radios, and the switch can be used for the power switch for the rig. A shaft extension is brought out to the front panel (a long screw, of the same thread used to mount the control knob on the front panel of the case with two or three of the machine screw standoffs. The speaker is then connected to the leads connected previously. The power and ground connections are connected to the proper terminals on the tr switch. Be careful to observe polarities. The output of the converter is now connected to the "ant" connection of the variable condenser. The other units can be interconnected, the battery mounted and wired, antenna connections made to the tr switch, etc. A DPDT switch works fine as a tr switch. This should complete the construction of the transceiver.

Tuning, final adjustments, etc.

Apply power to the converter and the bc radio. Tune the oscillator slug (L3) until the stage is oscillating (an increase in noise should be heard in the speaker). Connect an antenna or signal generator and tune L1 and L2 for maximum sensitivity. By tuning the antenna coil slightly higher in frequency than the mixer coil, it should be possible to get fairly good bandwidth from the converter. Peak the antenna trimmer in the bc radio for maximum signal near the center of the desired segment of the band. Take a small screwdriver and CAREFULLY tune the if transformers for maximum signal. On some radios, slight regeneration may be noticed when all of the *if* transformers are tuned to the same frequency. If it is severe enough to cause a hetrodyne on all received signals, detune the transformers slightly. A slight amount of regeneration may be helpful in improving the sensitivity. With slight regeneration, the sensitivity may be as much as twice what it was when the *if* was stable, without affecting the useful nf of the receiver. This will require some experimentation to find the optimum amount. A weak signal will usually quiet the hiss.

Tune the oscillator coil of the transmitter (L4) until the stage is oscillating. Make sure that a dummy load is connected to the antenna (a 47 ohm resistor will do); then tune the final for maximum rf. Watching the S meter of a monitor receiver will tell you if the oscillator is working and when things are tuned for maximum. Turn the modulation control at minimum and connect the microphone. Slowly advance the control until modulation seems to be around 90%. The modulator has more than enough gain for a crystal mike, and the modulation control is necessary. Be careful about overmodulation as the final transistor can be damaged by high audio peaks. With the values given, there should be an adequate safety factor at 100% modulation. If the oscillation quits when the final is loaded or modulated, take a turn off of the secondary of L4 to reduce the coupling. This should complete the tune-up of the xcvr. Connect an antenna and repeak L1 and L5.

For portable use, a whip antenna such as the Lafayette 99 G 3017 will work fine. I have used the rig with this whip and a beam and the results have been fantastic. With the whip antenna, stations as much as 100 miles away have been copied Q5. With the beam, it seems to receive as well as my Clegg 99'er. The transmitter is good for working local stations and it is much fun to see how far you can

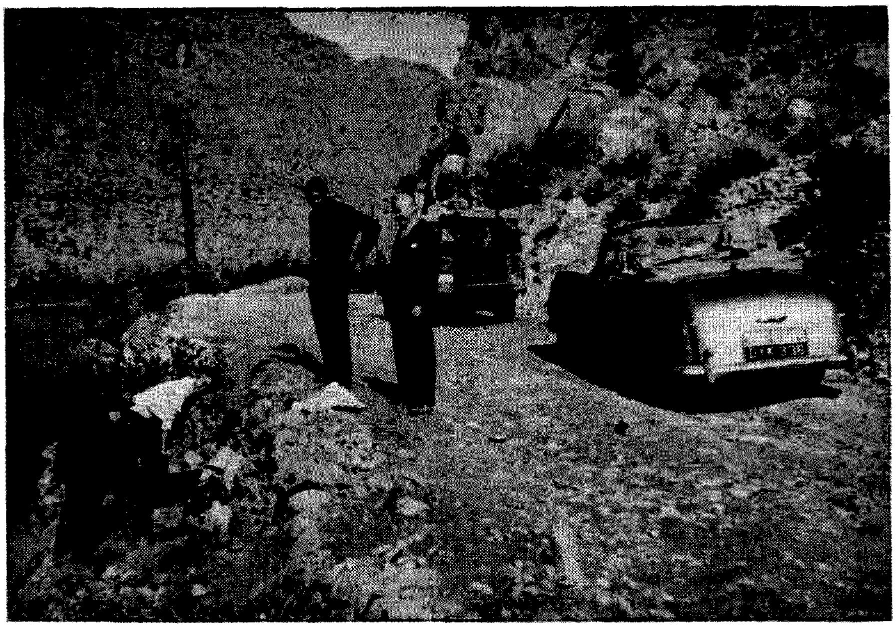


The transceiver as built in the Gold Plated Test Oscillator cabinet. Using a neater cabinet is permissible.

work with a few milliwatts. It is amazing what can be done with such low power. It is also nice to know that you have a complete working transceiver that is all solid state.

With much careful searching of the junk box, the rig can be built for under $20 and for that price, it is hard to find anything that will work better or you can have more fun with. For those who are lazy, you can use one of the little printed circuit converters sold by Vanguard Electronics and save yourself the trouble of building the converter, although it costs somewhat more. I tried substituting the converter section with one that I borrowed with satisfactory results, although the one that I tried was one of their older models that I hear they have since improved. Replacing the 2N2190's with RT82's resulted in a considerable improvement in performance. There was no problem experienced with bc feedthrough with either converter. Warm up your soldering iron and GOOD LUCK!

. . . WA2INM



In the Gorges of Dades. Left to right, CN8BS, Mrs. Peycelon cooking the picnic, CN8BC and Mr. Peycelon.

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A Visit to the CN8's

There are many reasons for visiting CN8 land in winter. Firstly, of course, it is nice to escape from a European winter. Secondly, CN8 is a delightful place to spend a holiday. That is, of course, if your idea of a holiday is to see something which is really *different* from your usual home surroundings. Different people, different food, different architecture, different scenery, different climate but, above all, a different civilization and a different way of life.

If you want to take your own way of life with you, live as you do at home, eat your usual food, drink your usual drinks, and mix with the same sort of people you meet at home, then, of course, you had better stay at home.

Above all, if you are the type of person who is a salesman at heart and longs to sell your way of life to people with a different way of life, then you had certainly better stay at home.

But if you travel to try and see and understand the way other people live, then your second or third visit to Morocco will be most enjoyable. Why not the first? Well—the first will also be enjoyable, but it is only a sample, skimming the surface. Everything will be so exciting, so strange, so unusual that you won't be able to get further than the surface. On your first visit you won't be able to meet many of the local people. That comes later.

When you have tasted the sample, you will come back for more, and after having digested the sample you will be in a better position to appreciate the country on your second or third visit.

This was my fifth visit and the full flavour was beginning to come out, as we no longer needed to see the obvious "sights," the tourist sights.

Now if you are fortunate enough to be a radio amateur, you have an enormous advantage over others who visit these countries. You

ve ready made introductions to a lot of ople—people you have talked to on the air; rhaps, even if this is your third visit, people 10 you have met in previous years.

So it was with me this time—my fifth visit th a number of interesting people whom I d met on previous visits and who were no nger strangers—people who introduced me to eir friends and so on.

This time we had a somewhat more comicated plan because my niece, a school acher, who accompanied me had only fairly ort holidays. So we decided to go down r South at once into the Anti-Atlas Mounins (my niece had already visited the North several occasions) and return to Casanca to put her on an aeroplane for home ile other friends wrom Paris arrived the me day to continue the trip.

So we struck South at once and although e boat had reached Tangier at midday we ent on to Rabat for the night. Owing to the cellent roads, this is quite easy although on is occasion owing to unusually heavy rain me parts were flooded and necessitated a tour.

At Rabat our radio friends already began to elcome us. CN8MT, Hamid Talby and the cond operator, Pierre Boissonier, welcomed . Pierre took us to Hamid's home where we ere received in a beautiful Moroccan room id had the Moroccan "aperitif" of mint tea ith his charming Moroccan wife, who served many varieties of sweetmeats. Hamid, as well being a radio amateur with one station on M and another on SSB, is a violinist and had leave us early that evening to play at a conrt. We went out to a typical Moroccan dinr in which the main dish was a Taiine of utton with almonds and raisins. We were ell and truly away from home already.

As we wanted to spend more time in the uth we left Rabat but knowing we would turn.

Next day a rapid run South to Assaouiro x-Mogador) where CN8BS had come spelly from Marrakech to welcome us.

So on South past Agadir—scene of the rrible earthquake of a few years ago—and up the Valley of the Souss which lies South the High Atlas Mountains, and is a wonrfully rich agricultural country with oranges, nons, grapefruit, bananas, olives and many er crops.

About 60 miles from the sea tucked in uth of the Atlas Mountains lies Taroudant. amazing sight! An old Arab walled city ng much as it has done for hundreds of ars.

Our hotel was inside the walls—an old palace which one enters directly through an enormous gate in the city wall. The Palace was built around court yards and all the windows face on to courtyards in which grow banana trees, oranges and grapefruit.

On our arrival we heard music. A "Moussem" was in progress, that is, a celebration for a Saints Day, and we asked if we might attend. The hotel sent a boy to guide us.

From Taroudant we proceeded South to another delightful walled city—Tiznit. Here the main activity is the jewelry trade. Craftsmen make gold and silver jewelry of all kinds which the Moroccan women wear in profusion. Gold and silver coins are made into bracelets, necklaces, etc. We spent a most enjoyable time visiting the souks and seeing this unspoiled and little visited gem.

Then we proeeded into the very heart of the Anti-Atlas Mountains a range which runs parallel to the High Atlas at its western end and about 70 miles further south. Here a first class tarred road has been built to connect the first-class road from Agadir to Tiznit on to Tafroute, but after the first 20 kilometers the road becomes distinctly mountainous, climbing with many turns and twists over some of the magnificent ranges of the Anti-Atlas which are rose-pink in color.

Tafroute itself is located in the center of two concentric rings of mountains, the nearer ones being appreciably lower than the further ones so that both ranges are visible from Tafroute. A magnificent spectacle! The floor of the valley of the inner circle is covered with almond trees, and the annular valley between the two ranges is rich with citrus fruit, dates, palms, almonds, olives, quinces and a curious form of palm producing a kind of chocolate. Here we were to spend several delightful days, wandering into the villages, making friends with the inhabitants, almost

CN8BB in his shack.

all of whom speak French. A curious fact is that a large proportion of the male population of this district goes to the North of Morocco from this valley to become the grocers and ironmongers of the rich agricultural district of Rharb.

At the end of our stay in Tafroute, my niece's holiday being nearly at an end, we made our way rapidly north to Casablanca. Here we were surprised to find a note in the hotel that a Mr. Soumet (of whom we had never heard) and some of the radio amateurs of Casablanca would call at our hotel at 19.30. The communications of the amateurs of Morocco were certainly good. Our arrival had been announced in advance almost everywhere we went!

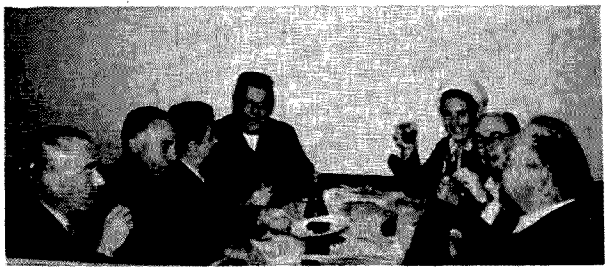
As we had already made arrangements to dine at the house of the nephew of CN8BB, we realized we had a full evening in front of us. Punctually at 7.30 Mr. Soumet, CN2BS, and about a dozen of the radio amateurs arrived at the hotel, and I was introduced to the President of the Moroccan Amateur Radio Club—M. Mohamed Hamidallah, CN8AF—who, on behalf of the radio amateurs of Morocco presented me with a beautiful bronze and also a silver buckle, of a type much used in the South of Morocco. This was not only a charming gesture but a very handsome present but, above all, it gave me the opportunity to meet the radio amateurs of Casablanca who have recently completely re-organized their Society and are starting in earnest to rebuild the local Society which had become more or less defunct.

Next day the change-over took place at Casablanca and we proceeded rapidly to Marrakech.

The area between Casablanca and Marrakech is a rich agricultural area in which enormous acreages of wheat and other cereals are grown. Here, we saw the local inhabitants ploughing these fields with a single furrow plough usually made of wood, drawn by a camel or a mule or two mules or a horse, and a donkey, or whatever it was.

And so we arrived at Marrakech where I immediately called on my very good friend—CN8BB—Roger Davize, who had been in Morocco since 1917, got interested in radio more or less professionally in 1923 and has had his amateur license since 1937 when he lived in Casablanca. Now he operates from the French Consulate in Marrakech.

He runs an SB10 to a home made 813 final, an NC300 and a Moseley Triband beam. He is probably one of the most active of the Moroccan amateurs.



At supper at Manolos. Mr. Peycelon, CN8AV, Mrs. Peycelon, CN8BS and XYL, G3BID and CN8BB.

We spent some time in Marrakech visiting the famous souks, the beautiful Dar Si Said Museum, ex palace, and—for the first time on my many visits to Marrakech, the Bahia Palace was open to view by the public—a really beautiful palace.

CN8BS, Jacques Dupre—one of my very best friends in Marrakech—had arranged to come with us over the Tizn-Tichka Pass (over 7000-ft) down to Ouarazate to show us the beauties of the Dades Valley.

In Ouarzazate again we met many friends. Thanks to CN8BS we had previously been introduced to M. Piallet, who is Headmaster of the local secondary school whose number of pupils has risen from 150 to 350 in two years. We were privileged to visit the school and to see the exercise books of the pupils. While the buildings are not impressive; (it is an old barracks used as a school), the standard of education certainly is, and we were very much impressed by the high standard in all the varieties of modern subjects taught in this school, particularly when it is borne in mind that the majority of the children are Berbers: their natural language is Berber and before education can really begin they have to learn both Arabic and French since the Berber language is not normally a written language.

The keenness of the pupils to learn and the energy and dedication of the teachers was a revelation.

We lunched with one of the teachers and his wife—who also teaches—who gave us a delicious meal: We dined with M. Paillet who included an unusual Moroccan dish—Beef cooked with prunes!

On another occasion we were invited by CN8BC—Brahim Sidate, who is one of the Moroccan operators trained by CN8BS who now operates professionally in Ouarzazate, as well as having his own station. He and his charming wife entertained us in true Moroccan fashion. The first dish was—Two rabbits cooked with almonds and raisins—completely delicious, and then followed the famous kous-

kous which takes about 5 hours to prepare, and which his wife had been busy preparing all day. What looks like rice is not rice. It is small granules of different types of flour mixed by the cook immersing her hand in water and then gently rubbing it over the board covered with three kinds of flour until the flour becomes little globules the size of grains of rice. This was used as the base on which to cook chickens with raisins, almonds and currants. These are not the battery fed, factory produced, hygienic, tasteless chickens. The chickens which fend for themselves eat whatever they can find and are really deliciously flavoured. All this, including the rabbits, was so beautifully cooked that it falls to pieces and knives and forks are not used. You merely take a piece of the rabbit or the chicken, pull it off and eat it. In the case of the kous-kous, this demands a certain skill. One should insert one's hand well into the rice-like flour to get the moist part from under the chicken and then by gradually tossing this in a circular motion in one's hand, it gradually becomes a ball preferably centered on a raisin, or a piece of onion, and if one is sufficiently dexterous one is able to flick this ball straight into one's mouth. Needless to say we were not expert and caused great amusement to our Moroccan hosts who tried to teach us the method of making the ball of kous-kous.

The excursion up the Dades Valley was most exciting. The melting snows of the Atlas Mountains have, in thousands of years, cut a narrow, deep gorge into the mountains, and after passing through this gorge—about 1,000-ft deep and only a few yards wide the river waters a fertile valley in which apricots, almonds, dates, etc. flourish.

Here the style of architecture is peculiarly beautiful as they have built the type of village called Ksar, or Kasbah. There are made of mud and are often beautifully decorated but perhaps the most striking thing is their eye for proportion.

And so we returned to Ouarzazate.

Next day something extraordinary happened—extraordinary for the Moroccans but not for us. It rained! No rain had been seen in Ouarzazate for two years. The day it rained was to have been the Market Day, and we were looking forward to the market at Ouarzazate but when it rains in Ouarzazate there is no market day. We were somewhat surprised that the Market Day was called off owing to the rain until the locals reminded us that in England cricket matches are cancelled by the rain; in America baseball matches are cancelled by the rain, everywhere tennis is cancelled by the rain, so why not the Market Day.

We returned again to Marrakech to meet our numerous friends, and so gradually homeward over the rich agricultural area where we again saw the camels and the donkeys, the mules and the horses slowly ploughing the fields. Obviously this method of ploughing is so slow that it is not possible to plough all the available fertile land. Far from it. Only a small proportion is actually ploughed.

This led to the comment by us, as Europeans, whether it would not be better if these people had tractors and multi-furrow ploughs. Could they not produce much more wheat?

In America today a subsidy is paid to farmers who do not sow wheat, who restrict their acreage of cotton and on several other commodities payments are made by the Government in order to prevent an increase in the cultivated area. In France the Government pays a subsidy for tearing up vines.

Is it really more sensible to spend large sums of money on tractors, large sums of money on ploughs, and then have to pay out further large sums of money to persuade people not to use them?

Here there is less danger of the over-production which the West suffers. They can only plough a certain acreage in the day—quite enough to feed the local population but not enough to produce a serious surplus problem.

This is not to suggest that the single furrow wooden plough should be introduced into the wheat lands of the United States but it is to question whether in our so-called Western civilization we are right to pursue increased production until we achieve chronic over-production, only to have to give subsidies to prevent further over-production. It is to suggest that there is a balance between the insensate urge to over-produce which now seems to dominate Western minds and the older conservative continued use of primitive methods. Would it not be better if we were to devote a little more time, above all a little more thought, to the question of a balanced civilization rather than the blind pursuit of over-production, followed by the energetic pursuing of a sales campaign to cope with the accumulated surplus?

The failure of the Russian wheat crop has certainly helped the United States to dispose of a large amount of her surplus wheat but we should not let this obscure the main issue which is—do we want to insensate over-production followed by insensate sales campaign, or a balanced civilization? . . . G3BID

Fred Blechman K6UGT
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Canoga Park, California

The Pot-Box

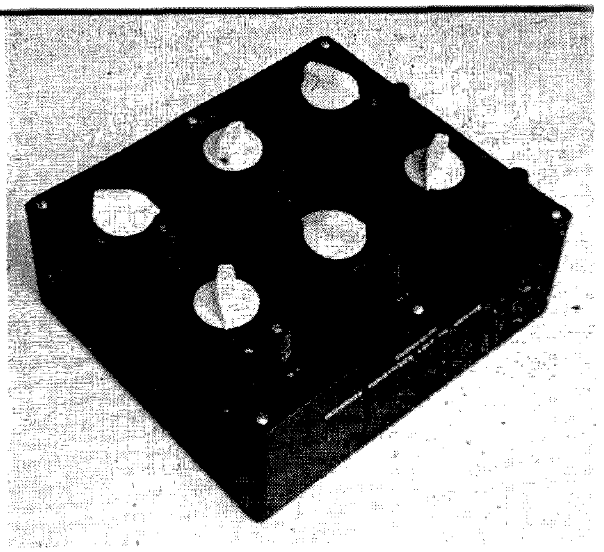


Fig. 2. The second Pot Box has calibrated dials.

How many times have you had to hunt through your junk box looking for a potentiometer of just the right value for a breadboard circuit? Finally, finding one you hope will do, you precariously perch the pot on the workbench and gingerly attach it to the circuit with clip leads. Then, ever so gently (for fear of upsetting the whole rat's nest of wires) you rotate the potentiometer shaft. Sometimes this takes a screwdriver and three hands, but somehow you manage. After trying two or three different potentiometers, you finally find one that's the proper range, and set it to the position that gives the desired circuit effect. Now you'll probably want to replace the potentiometer with a fixed resistor—but what value? Out comes the ohmmeter and more lead maneuvering. . . .

Well, with the "invention" of the Pot-Box, many of the difficulties just described are eliminated. Essentially a Potentiometer Substitution Box (much like familiar resistor and capacitor substitution boxes) the Pot-Box contains six decade-valued potentiometers, each wired to three binding posts on the front panel. Each pot has a knob; a pointer and calibrated scale (*not* shown in the photos) could easily be added, instead of using an ohmmeter to measure the resistance of the potentiometer at the given position.

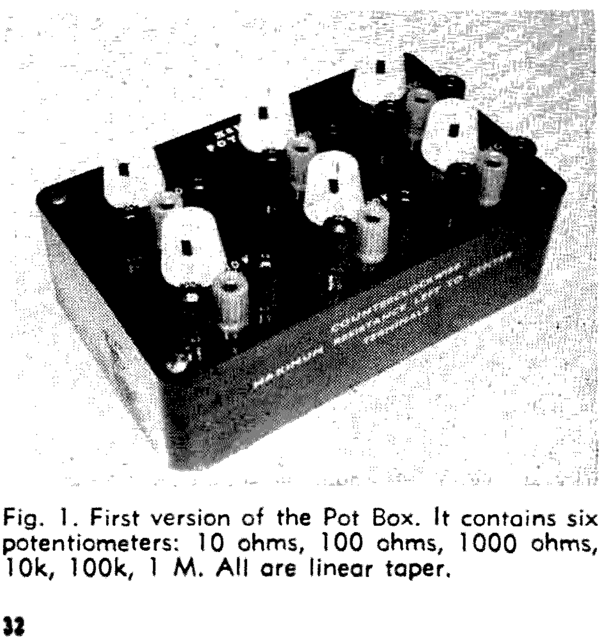


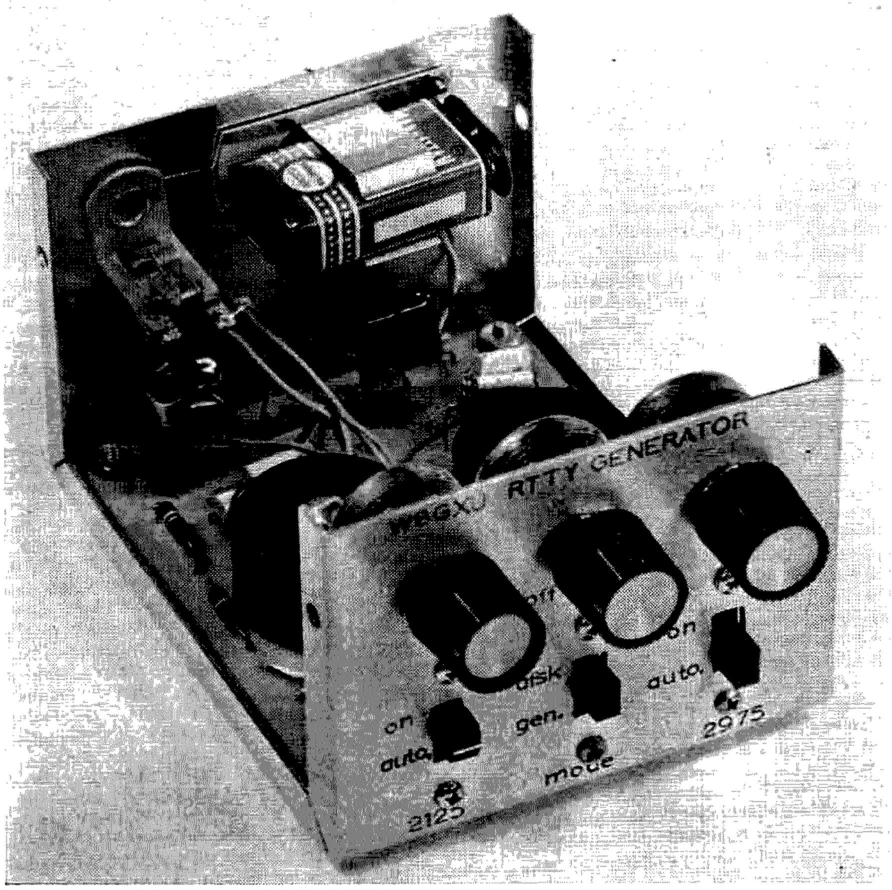
Fig. 1. First version of the Pot Box. It contains six potentiometers: 10 ohms, 100 ohms, 1000 ohms, 10k, 100k, 1 M. All are linear taper.

In use, the 5-way binding posts allow wires, clip-leads, lugs, banana plugs and probe tips to be connected to either the clockwise-increasing or clockwise-decreasing resistance terminals of the individual potentiometers. As shown, center-to-left terminal results in clockwise-decreasing resistance (which is increasing current in most circuits). Although each potentiometer is separate, series and parallel interconnections can be made at the binding posts to obtain odd tapers (rate of change in resistance with rotation) and in-between potentiometer values.

Construction of the Pot-Box is straightforward. The author's first unit ended up too cramped, so a larger bakelite instrument case and panel are recommended. Bakelite is suggested, since it eliminates the need to insulate each binding post from the panel. An even larger box, perhaps with a masonite panel, might be used if you intend to add calibrated scales, which should show both clockwise-increasing and clockwise-decreasing values as determined by your best ohmmeter. Common 2-watt potentiometers were used in the model, but if you so desire, higher rated units may be used.

The convenience of the Pot-Box is hard to appreciate until used. Since being built, it has found repeated use at the author's workbench, from checking meter movements (use the Pot-Box in series with a battery and a known good milliameter. Start with a high value pot and work down), to establishing proper transistor biasing resistor values. In critical circuits, where a resistance substitution box jumps the gap, the Pot-Box is worth its weight in Green Stamps! Modest in cost, modest in size, and modest in effort, the Pot-Box is real robust in usefulness.

. . . K6UGT



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A Signal Generator for the RTTY Man

(And for the AM and SSB man as well)

The serious RTTY experimenter is often plagued by lack of consistent signals on the air with which to test and adjust experimental terminal unit circuits. If one is blessed with a model 19, he can punch a test tape, feed it to an AFSK and he has a signal. But having only a model 15, I soon developed a tired arm from shifting the audio generator back and forth, from the mark to the space frequency. This being the age of automation, I came to the conclusion that there should be a better way.

The "conclusion" is shown in schematic form on **Fig. 1.** Basically it is a free-running multivibrator, modified to produce true square wave on its collectors. Each collector keys an audio generator, set to the mark and space frequency respectively. To simulate QSB on the air, the output of each audio oscillator is made variable. To simulate interference, each oscillator can be turned on continuously. This feature makes the unit useful in SSB and AM transmitter modulation checks. The tones are very clean sinewaves, at over one volt out. And just so the unit does not collect dust after that "perfect" terminal unit is built, it can be changed to an AFSK simply by "slaving" the multivibrator to the machine's keyboard switch.

Circuit description

The collectors of the multivibrator vary in voltage from about ground potential to full supply voltage, with the on and off period each set to near 22 milliseconds. When a collector is at supply voltage, it feeds forward bias to its

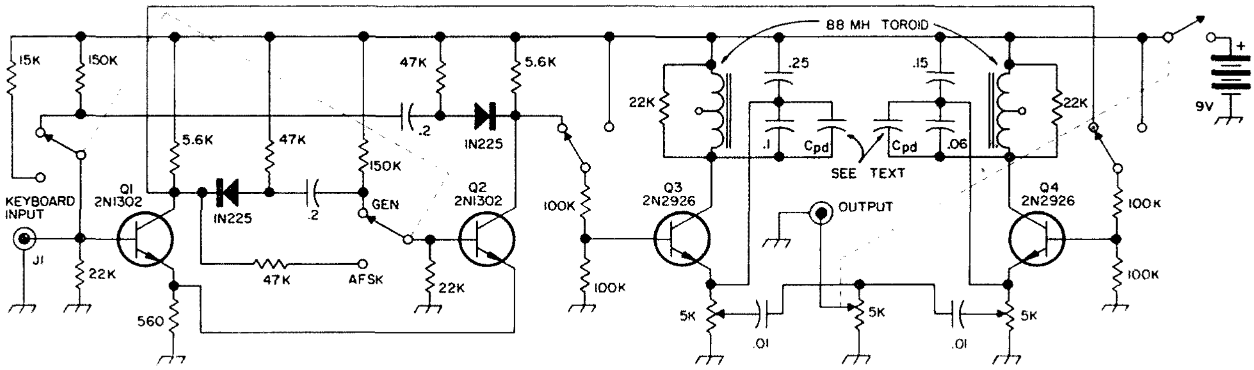
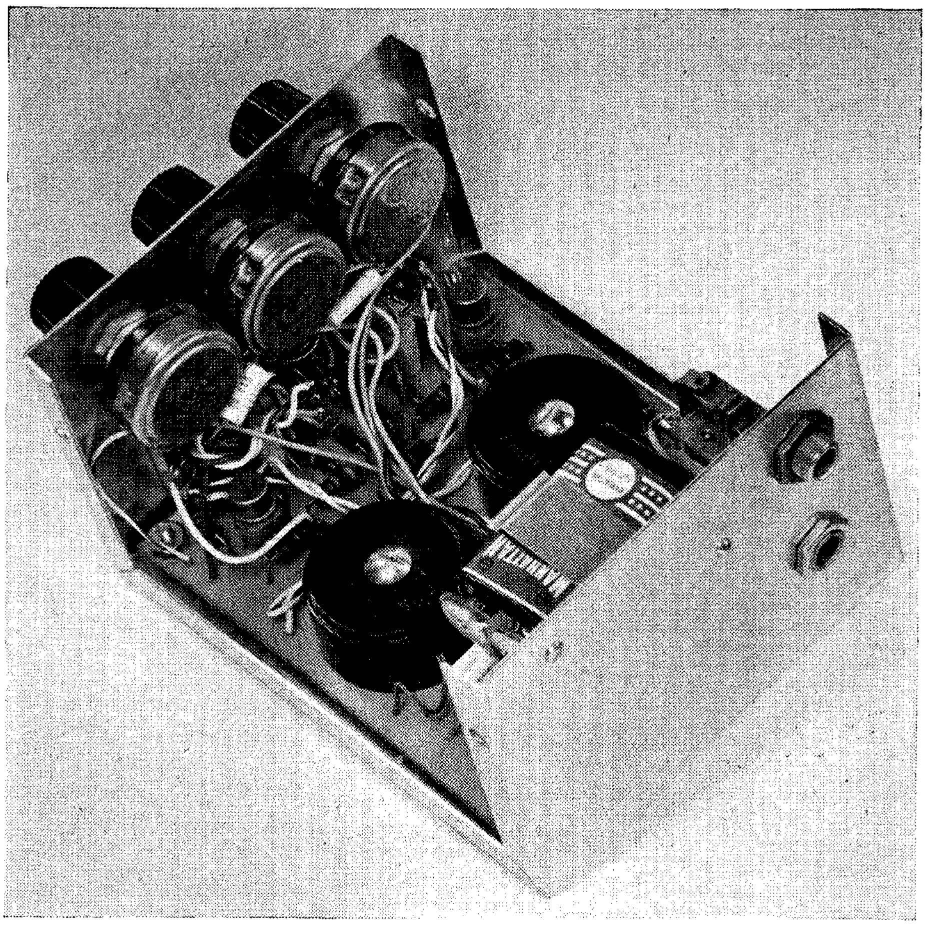


Fig. 1. This schematic of the RTTY Signal Generator shows the simple circuitry. The two 2N1302's form a multivibrator which alternately turns on the two audio oscillators.

oscillator turning it on. The audio oscillator transistors are high quality but inexpensive silicon transistors in a Colpitts circuit. The popular 88 mh telephone loading coils are used in the audio tuned circuits. The oscillator outputs feed a 5 K overall output control.

The bases of the multivibrator transistors can be switched to give either free running or "slaved" operation. In the "slaved" or AFSK mode, the free running multivibrator is converted to a variation of the Schmitt Trigger. The machine keyboard is plugged into J1. The keyboard is normally closed resulting in a short from base of Q1 to ground. With the base shorted, the collector of Q1 is at supply potential. The 2125 cycles per second (mark) oscillator is now on. With the collector of Q1 at supply potential, Q2 receives base current, dropping its collector to near ground potential. The 2975 cycles per second (space) oscillator is lacking base bias and is therefore off.

When printing, the keyboard circuit opens while forming the space part of the code. When the keyboard opens, the base of Q1 receives bias through the 15 K resistor, and the collector of Q1 drops to ground, removing



This view shows the various controls and the method of construction. The two 88 mh toroidal coils are in the center of the circuit board.

base current from Q2, whose collector now rises to supply voltage. The 2975 cycles per second oscillator is now on while the 2125 cycles per second oscillator is off.

Construction

Most of the parts except the controls and jacks were assembled on a perforated fiber board, and then mounted in a 4" x 5" x 7" Minibox. The 9 volt transistor radio battery which powers the whole unit at a drain of only 4 ma, is mounted on a clip on the rear of the box. The front panel is lettered and given several thin coats of clear acrylic spray. The lettering gives the unit that almost manufactured look.

Adjustment

If care is used in wiring, the only adjustments needed will be to set the oscillators to frequency. The best way to do this is by use of a digital counter, but an accurately calibrated audio oscillator will do in a pinch. The oscillators are each turned on continuously and small fixed capacitors (Cpd) are added across each tuned circuit to bring it to frequency. Small ceramic capacitors can be used for padding to frequency.

The multivibrator timing will be in the ball park if the components used are those indicated on the parts list. Accuracy here is not paramount. Anything close to 22 milliseconds by 5 milliseconds will do.

Uses of the generator

When this unit is completed, you have a very useful tool to aid you in perfecting terminal units. No longer is one dependent on an off the air signal, and yet all the variations of a real signal can be duplicated by this unit.

Normally, the machine is off. The keying magnet coil is wired to the experimental terminal unit with a small (10 ohm) series resistor. An oscilloscope is placed across the 10 ohm resistor and monitors current through the magnet coil. The results of any changes in terminal unit circuitry can now be monitored on the scope.

By turning one or both oscillators on continuously, the unit can be used as AM or SSB generator. The clean sine wave output can be quite handy in spotting distortion in transmitter stages.

And, of course, by plugging in the keyboard, you have an AFSK to modulate a VHF transmitter directly.

. . . W8GXU

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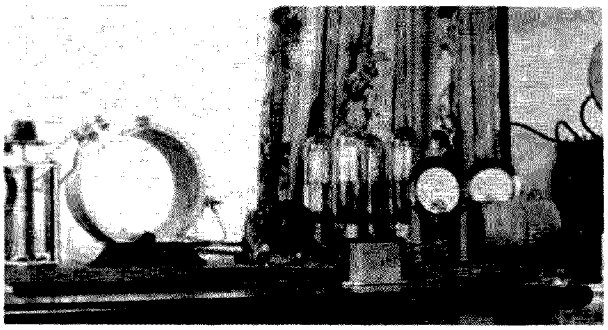
"This is Fine Day"

Hamdom thrilled all over again the night three amateurs bridged the Atlantic and worked intercontinental DX for the first time. It happened forty-two years ago. At the time, every continent heard American signals and Americans heard some of the Europeans. Yet, no one could make a contact. Finally a Frenchman suggested experimenting on a lower wavelength. Down went the barrier and the famous Franco-American "two-way" crossed the sea.

Following the success of the second Trans-Atlantic tests in December 1921—both American and Canadian signals "got across"—the American Radio Relay League dreamed of intercontinental ragchews and a world-wide net. Hams, fired with new enthusiasm, set out to oblige. But, when QSOs continued to elude everyone, the ARRL announced the third Trans-Atlantic test for December 1922.



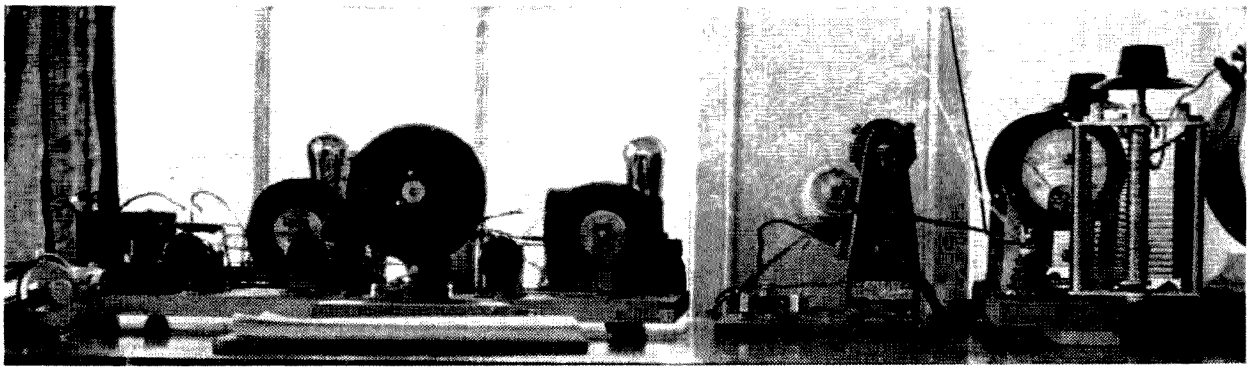
The pushpull-parallel transmitter Fred Schnell used at 1MO for the historic intercontinental amateur QSO.

This time the Europeans transmitted too. In a two-part program, Europe listened for North American signals during the first half and Americans and Canadians stood-by for the second. How close the League's "dream" lay to fulfillment quickly became evident when European amateurs snared scads of United States stations during the American 1200-mile qualifying trials alone. Later, when the test came off, American signals descended on Europe like crows onto a corn field. And, for the first time, *America copied signals from two of the countries on the "other side."*

Spurred by the unqualified success of the third Trans-Atlantic test, the ARRL scheduled a fourth for twelve months later. Again amateur excitement flamed fever high. But the fire died down before the fourth ever materialized. One month before, two New Englanders worked the same French station on the same night. In a message to America the Frenchman said, "This is fine day!" How true! It brought the harmonically related wavelengths to amateur radio and ushered in the era of world-wide DX.

DX fever

Ham enthusiasm rocketed sky-high following the outstanding success of the third Trans-Atlantic test of December 1922. Every United States district got across. British hams heard



The "pile-of-junk" receiver Schnell used to receive 8AB's transmissions.

161 Americans and Canadians; French and Swiss amateurs, 239. And, for the first time, French and English signals spilled over the Atlantic onto American soil. All in the 200-meter range. "Why then," asked the amateurs, "no contacts? What elusive secret holds back QSOs?"

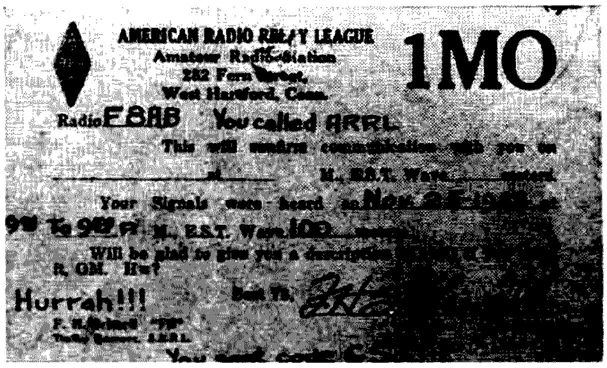
Pacific DX seemed easier. Daily, new records came to light. Amateur 6ALE in Reedley, California, pushed his signals into 1-land and believed he set a CW record. (1ES in New England copied him on 208 meters for several minutes). 6ZAC in Wailuku, Maui, Hawaii, then startled hamdom with a list he sent to ARRL showing 5-, 6-, 7-, and 9-district stations he copied regularly. Some 6's and 7's found conditions so excellent they broadcasted messages "blindly" to 6ZAC. Providing harmonic QRM from NPM's arc transmitter at Honolulu stayed weak, they received acknowledgement of their transmissions either by cable or mail.

Now a buzz of comment disproved 6ALE's claim to a record. Complainants cited 6XAD's performance from Avalon, Catalina Island, California. He not only repeatedly copied stations up and down the Atlantic seaboard and put his signals into their territory, he worked many of those he heard. And he didn't use a kilowatt either. Four Western Electric VT-2 tubes made up the transmitter and only a detector and two audio stages the receiver. Numerous 8's in New York state roared from the earphones with such volume 6XAD copied them 100 feet away. 3AQR at Hershey, Pennsylvania, worked him just about any time he pleased as did 3ALN in Washington, D.C.; 8JL, Cleveland; and 9AJA in Chicago. But to cap the lot, word arrived from "down under" that Sidney, Australia, heard 6XAD's signals too.

About this time relaying showed it could hold its place in the crowd also. On the spur of the moment one night, ARRL headquarters at Hartford, Connecticut, originated a message for Hawaii and sent it out over their station 1AW. It read, "What time is it there?" In four minutes and eighteen seconds they knew. "Eleven thirty-five." A new record. From Hartford to Sleepy Eye, Minnesota, to Hawaii; and back over the same route. Ten thousand miles in just over four minutes. With such performance how much longer could intercontinental QSO's hold out?

In Europe, DX fever prevailed too. But methods differed. Where United States hams built sturdy, professional rigs and concentrated on relaying, the "Continental crowd" stuck more to breadboards for easy experimenting. Nevertheless, they all aimed for the same thing – intercontinental QSOs. Not corralled between 150 and 220 meters like the Americans, many foreign hams experimented on the shorter waves. One of these experimenters, Leon Deloy, operated on various short wavelengths from his home at 55 Boulevard Mont Boron, Nice, France. Night and day a 45 meter signal poured forth in his shack from 435

Deloy at his operating table with Grebe 13 receiver on the left.



The QSL card Fred Schnell, 1MO, sent 8AB after receiving his signals November 25, 1923.

miles away. Deloy possessed a vast background of experience with the higher frequencies through his work with the French government communications activity. Operating under the call 8AB, his 900-mile shortwave contact with Scotland stood as a record of the day.

During the third Trans-Atlantic tests, only 8AB and two Englishmen, 2FZ and 5WS, managed to force their signals across the Atlantic to America. However all arrived weak. Following the tests, Deloy dropped back from 190 meters to the shortwaves where signals seemed to "go places" with less effort. England immediately confirmed his 100-meter signals loud and clear. Continuing to operate in this area where his confidence lay, where boundaries of nations disappeared, and where confusion reigned from lack of national prefixes, Deloy pondered the weakness of his one kilowatt signals in America. Why did American signals come in so loudly? Many boasted only flea power. Determined to find out, he booked passage for America.

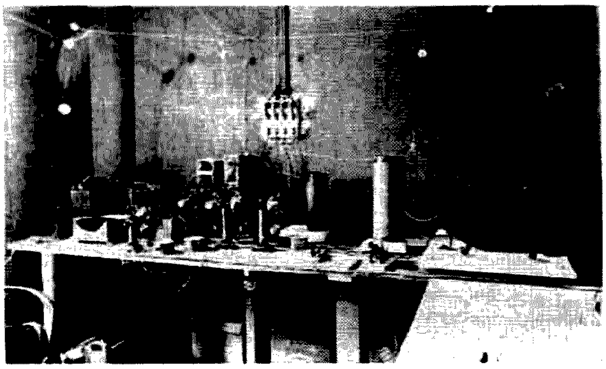
Already familiar with America from his World War I stay three years before in the service of the French government, France's leading amateur timed his visit to coincide with the 2nd National ARRL Convention held in Chicago September 12 to 15. Delighted to see such a distinguished visitor, ARRL officials asked him to speak. They knew the interest his monthly QST column held for the group. Equally conversant in English or French, Deloy explained the tendency of French amateurs to experiment rather than relay, and informed the gathering that the fourth Trans-Atlantic tests just three months away would find three new French kilowatts vying to reach American ears. To the honor of "first French station to hurdle the Atlantic," Deloy vowed to increase 8AB's renown by winning out over competition and participating in the first intercontinental QSO.

Deloy talked with as many hams as possible at the convention to learn all he could of American methods. Later, he visited a number of the leading amateur stations. His visit lasted one month. Back on the east coast, 8AB and Fred Schnell, ARRL's Traffic Manager, agreed to conduct tests as soon as possible to try to establish the first intercontinental contact. Deloy promised to wire 1MO when ready. Before sailing, 8AB dropped in on John Reinartz at South Manchester, Connecticut. There 1XAM's tuned feeder system immediately captured his interest. Tuning equalized the current in the antenna and counterpoise decreasing the input power and raising the efficiency. Intrigued, 8AB departed for France determined to adopt the idea as soon as he got back.

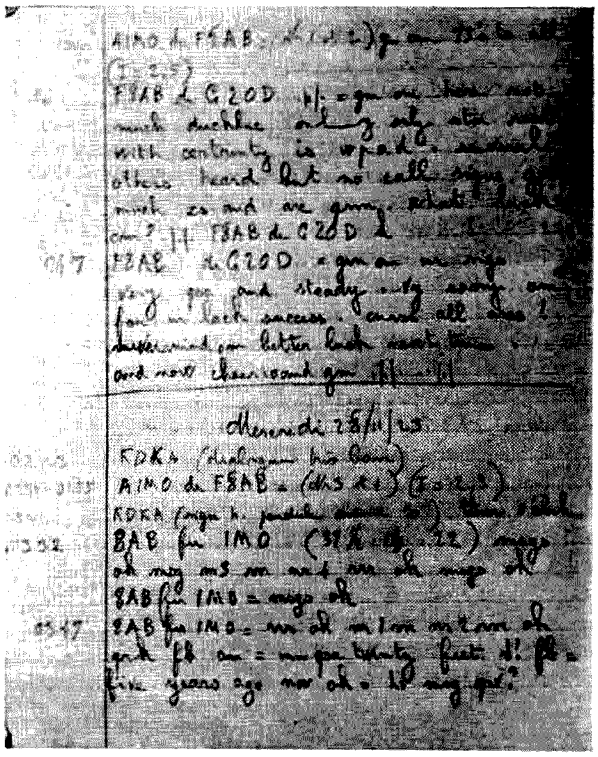
Over the waves

Deloy's cable to Schnell started things humming in 1MO's shack. "WILL TRANSMIT ON *100 METERS* FROM 9 TO 10 PM EST NOVEMBER 25 – DELOY". Out came the American Beauty soldering iron. Amid acrid fumes of heated rosin mingled with sweat, Schnell raced against time. The receiver needed some redesign. Peaked for reception in the amateur 150- to 220-meter range, Schnell felt it inadequate for the lower wavelength. Soon a new front end replaced the old. Otherwise, the set remained much as it was: a couple of cardboard tubes with a few turns of wire in an ordinary tickler circuit, a four-plate condenser, and a detector followed by one audio stage all spread out across an open breadboard. In the words of some ARRL officials at the time, "Just a pile of junk."

On the night of November 25th, Schnell and QST Editor, K. B. Warner, sat in the heated sun parlor of their shared home at 282 Fern Street, West Hartford, Connecticut. Outside snow lay on the ground. The remodeled, nondescript receiver spread before them already tuned to 100 meters. A clock indicated eight



One of Leon Deloy's experimental shortwave setups. Note 250 watt French tubes.



Part of Deloy's log book record of the famous intercontinental QSO. Note the "A" before 1MO and 1XAM used by him to designate American stations. International identifying prefixes didn't go into effect until January 1, 1929.

fifty-two. They waited. Faces tense with anxiety and expectation, they watched the remaining minutes tick by. Now only five . . . three . . . two . . . With fifteen seconds to go, they unconsciously bent forward concentrating on the background noise coming from the loudspeaker.

At Nice, France, a city back from the Mediterranean sea with mountains in the distance, the climate of Miami, Florida, prevailed. In a few minutes the clocks would strike three. Above a certain three-story house an inverted "L" four-wire-cage flat-top swayed slightly in the night breeze stretched tightly between 3-foot spreaders 76 feet above ground. A 46-foot-long two-wire lead-in slanted down from one end and disappeared into a lighted third-story room. Completing the radiating system, a cage counterpoise three feet in diameter extended nearly under the antenna from the radio room to a terminus six feet above ground. Inside the room, his features bathed in the soft glow from a pair of 250-watters, Leon Deloy sat at the operating table his hand poised above the key. He waited for 200 GMT sharp.

Before him spread a breadboard transmitter patterned after the modified Hartley of John Reinartz. However, in place of the single 50-watt tube used at IXAM, Deloy used a pair of S.I.F. 250-watt French tubes in parallel. The plate to filament resistance of a French 50-watt tube served as a grid leak—a suggestion of another American amateur, T. Appleby. To the right of the transmitter lay the high voltage power supply. Four transformers, with primaries in parallel and secondaries in series, raised Nice's 110 volt 25-cycle house current to 5000 volts and socked the oscillator plates with raw a-c.

The receiver sat at Deloy's left. A Grebe-13. This special amateur receiver contained one stage of tuned r.f. loosely coupled to a detector and tuned from 80 to 300 meters. In addition to this professional job, Deloy possessed other receivers including an experimental superhet. As he watched the final seconds tick by, he wondered if tonight's attempt would bring success. A previous try with 1CKP of Connecticut from January 26 to February 3 the past winter, failed. One second left! The hand over the key moved. Lights in the shack dipped and a loose lamination buzzed.

Promptly at 9 PM a strong, fluttering gargle snapped the tension at 1MO. Readability extended to twenty-five feet. Deloy, or some local? Impatiently Schnell and Warner waited as the operator slowly sent. ARRL came through first followed by the cipher group GSJTP. Then all doubt vanished. The calling station signed 8AB French! Deloy sent for one hour. A call from 1MO to John Reinartz determined that 1XAM received the Frenchman's signals equally well. There two stages of audio behind a Reinartz tuner produced room volume from a loudspeaker. Schnell cabled Deloy the good news.

Encouraged by Schnell's cablegram, 8AB sent two messages "blind" the next night. One conveyed most hearty greetings from French to American amateurs; the other proposed trying a "two-way" near 100 meters the following night. The second message fostered a beehive of activity at 1MO and IXAM. One hundred meters lay outside the amateur band; to transmit on that wavelength required a special license. Could they get one in time? Schnell cabled 8AB acknowledgement of both messages. The next day he and IXAM dashed to Boston to plead their case with the Radio Inspector. Both emerged with a temporary ticket. Back at their stations, Schnell tuned to 110 meters and Reinartz settled on 115. Ready at last, they nervously awaited the transmission from France.

Deloy didn't keep them waiting. At 9:30 PM his 3-ampere signals pounded in again as he called America for one hour and sent two

more messages. Then he signed asking for a QSL. Schnell pressed his key. One and a half amperes surged through balanced feeds. One excited the six-wire cage antenna twelve inches across and 70 feet high; the other, a six-wire counterpoise with the wires fanned out at one end. Behind the 120-cycle note, four 50-watters operated in a self-rectified, pushpull-parallel circuit with 1500 volts on the plates. Five kilocycles away, Reinartz transmitted too. If one couldn't get across, perhaps the other would. Schnell finished his long call and signed 1MO. Tension soared.

Deloy came right back. Asking Reinartz to QRX, he sent the following to Schnell: "R R QRK UR SIGS QSA VY ONE FOOT FROM PHONES ON GREBE FB OM HEARTY CONGRATULATIONS THIS IS FINE DAY . . . " A few messages followed then some rag-chewing with the Frenchman by Warner, Reinartz, and Schnell. Finally, as daylight broke in southern France, transmitter trouble developed at 8AB and Deloy hurriedly left the air.

Conclusion

The 3400 mile 8AB-1MO/1XAM contact awakened American hamdom to the value of shortwaves. As more and more amateurs listened on 100 meters, 8AB's range extended to

Leon Deloy on the streets of Nice, France, 41 years after the famous Franco-American QSO.

California then on to the countries "down under". Western hams in the United States who already received 200 meter "heard" reports from as far away as New Zealand, envisioned the shorter waves transforming these reports into intriguing QSOs. Now American amateurs shouted for what they wouldn't use a few years before. The resultant clamor, with full ARRL support, fell on friendly Government ears. On July 24, 1924, the Department of Commerce reduced the existing band from 220 to 200 meters and assigned the harmonically-related bands to the hams.

As Americans hams became active on the new bands, contacts soon jumped national boundaries and ran into the same difficulty Deloy experienced some time before—identification. A 2AB might operate in Spain, France, or the United States. Deloy solved the problem by writing initials ahead of the call. In his log book "G" stood for Great Britain and "A" for America. Later, "intermediates" between calling and called stations helped. But the problem stayed unsettled until January 1, 1929, when prefixes agreed to at the Washington International Conference went into effect.

Today, Fred Schnell operates from Florida under the call W4CF. Leon Deloy whom a Canadian once called "the father of shortwaves", remains inactive in Monaco landlocked by a Principality law that forbids transmission outside the country. Reinartz, whose transmitter circuit all three stations used, in later years operated K6BJ in California until he became a silent key October 5, 1964.

. . . W2AAA

Jim Fisk WA6BSO

Transistor Meter Amplifiers

Sensitive meter movements are the backbone of all accurate electronic measurements but their expense limits their use to all but the most costly instruments. If you have priced a 0-25 or 0-50 microampere meter in the past few years you know why inexpensive meter amplifiers are useful. At one time sensitive meters could be obtained quite inexpensively on the surplus market, but nowadays even surplus meter prices are prohibitive.

With transistors it is quite easy to build a meter amplifier that is inexpensive, portable, and extremely sensitive. Depending on the planned usage, several types of amplifiers are available which are suitable for this purpose. These circuits vary all the way from the most simple to the quite exotic. Of course, the simple circuits are limited; the more sophisticated circuits allow for such things as gain control, linearity and meter zeroing. In most cases drift in a properly designed unit will be negligible.

Most amateurs are familiar with the simple meter amplifier circuit shown in **Fig. 1.** This arrangement has been used extensively in transistorized "grid-dip" meters and other units where only relative readings are of interest. In this circuit the only components are a transistor and its associated battery; you can't get much simpler than that! Admittedly, this circuit is very limited and suffers from several serious disadvantages. Probably foremost among these limitations is that the gain is dictated completely by the transistor. Furthermore, if the transistor is chosen without a little forethought, meter drift may become very serious. For this reason, a silicon transistor with extremely small reverse leakage should be used. Linearity may also be a problem in some applications, but where only relative readings are of interest, this may usually be neglected.

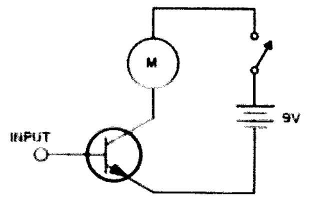


Fig. 1. Simple meter amplifier.

A more generally useful transistorized meter amplifier is shown schematically in **Fig. 2.** This bridge type circuit overcomes the major disadvantages of the simple circuit by the addition of three resistors. The gain control and the transistor form one leg of the bridge while the zero control forms the other. Since the circuit is essentially a voltage amplifier, gain is easily controlled as is linearity. In the simple circuit previously described, the gain was dictated by the current gain of the transistor, but in the bridge arrangement almost any desired amount of gain may be obtained by the proper choice of resistances.

In the bridge circuit a small current at the transistor base is amplified by the transistor to a larger current in the collector; the increase in collector current reduces the voltage at the collector and unbalances the bridge. The amount of unbalance is indicated on the milliammeter. Since the voltage gain of a transistor circuit is proportional to the collector load resistance, this circuit may be adjusted to nearly any specified gain. Because of its shunting effect, the optimum value of zero adjusting resistance is determined by circuit gain.

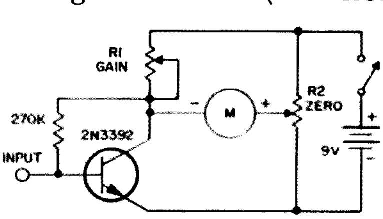
It is not absolutely necessary to use the 2N3392 transistor shown in the diagram, but other transistor types will likely require different resistance values. This particular transistor was chosen on the basis of cost (69¢) and low leakage current (0.1 microampere at room temperature). Silicon transistors are recommended for this circuit because they are less susceptible than germanium to the effects of temperature.

As shown in **Fig. 2,** the gain of this circuit may be varied to almost any desired amount. In the most sensitive arrangement (gain of 75-100) a one milliampere meter movement may be used to measure a full scale current of ten microamperes. This is sensitive enough for nearly any application; if used in a voltmeter, this corresponds to 100,000 ohms per volt.

One small word of caution should be extended concerning the choice of a meter movement. A good name brand meter should be used if at all possible. Most of the cases of nonlinearity associated with this circuit have been traced to inexpensive meters. The low cost Japanese meters are particularly bad in this respect; scale nonlinearities on the order of 20% are not unusual, at least on the units I have tested. Of course, it's like anything else, you pay your money and take your choice.

Adjustment of this circuit is simplicity itself. With no input, turn the circuit on and adjust the zero gain control so that the needle is off the pin. Use a little care during this initial operation because the circuit will probably be extremely unbalanced. The use of a small shunting resistance or "meter protector" is recommended in the initial phases of zeroing to prevent damage to the instrument. After the initial zero is obtained, each time the gain potentiometer is changed it is necessary to re-zero the circuit.

The meter is calibrated by applying a known current to the base of the transistor and alternately adjusting the gain and zero controls until the desired full scale reading is obtained. For instance, 10 microampere amplifier could be calibrated with a 1 megohm resistor in series with the transistor base and a 10 volt battery. This arrangement would provide 10 microamperes full scale. To check linearity, a 2 megohm resistor (5 microamperes) should



GAIN	R1	R2
5-10	1K	50K
10-40	5K	20K
40-80	5K	10K
75-150	10K	5K

Fig. 2. Bridge type meter amplifier.

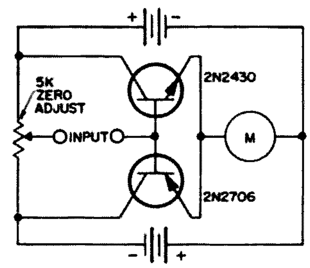


Fig. 3. Null amplifier.

provide a half-scale reading.

Incidentally, one advantage of the bridge type meter amplifier is that zero current may be set at any point on the meter. In other words, a regualr meter could be used as a zero center instrument. If the 10 microampere circuit were adjusted to zero center, a 5-0-5 microampere device would result; just try pricing an instrument with that sensitivity! Use of very large currents with a zero center may not provide useable results however, because the circuit does not have much negative range.

A simple meter amplifier designed for use with zero center meters and useful in null networks is illustrated in **Fig. 3.** It is particularly useful in instruments where high-accuracy measurements are necessary but a relatively rugged inexpensive meter movement is required.

In this circuit a pair of complimentary transistors are operated in push-pull. The current gain of the amplifier with the transistors shown varies between 50 and 100, the nominal range of the transistors shown in the circuit. If more gain is desired, the transistors may be cascaded. Due to the complimentary nature of the circuit, it is extremely stable with temperature; drift of between 0.2 and 0.1 microamperes has been experienced over a three hour period.

The resistance of the potentiometer is not at all critical; it is used simply to center the needle of the meter. Almost any junk-box potentiometer will work.

Although the use of matched transistors is not required, the unit will be considerably more stable if matched devices are used. The Amperex 2N2430 and 2N2706 may be obtained as a matched pair under the part number 2N2707. The matched pair is only about 10¢ more than the individual transistors so is well worth it in terms of the excellent results obtained. The main disadvantage of this circuit is that both negative and positive batteries are required, but considering the simplicity of the circuit, this is not considered to be too serious.

. . . WA6BSO

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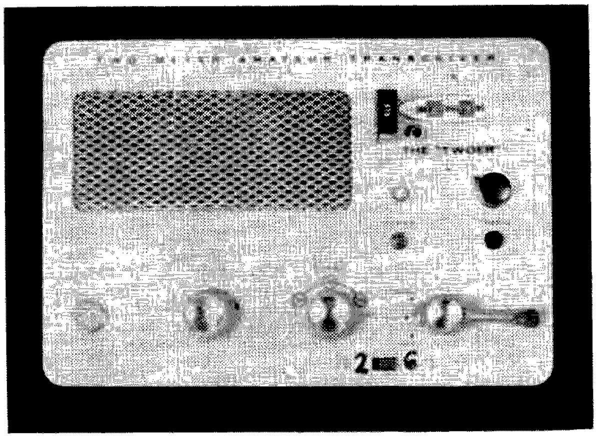


The Twixer

Add six to your Two'er

After building a simplified 6 meter version of K8KDX/6's 6 and 2 meter portable[1], I became intrigued with the idea of adding 6 meter (50 to 52 mc.) coverage to my Heathkit Two'er.

It was desirable to get a rig which used as much of the Two'er's circuits as possible. Fortunately, by reworking the power supply a bit, one section of the Tx/Rx switch was freed to be used to switch the 6 meter antenna. The Tx/Rx switch will now serve whichever rig is on. Band switching is done in the filament line, and the tubes are wired to allow for 6 or 12 volt operation. The result of this article is a 6 and 2 meter rig in the Two'er case. Handy!

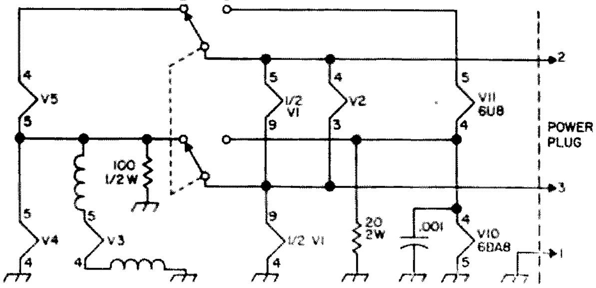


Fig. 1. Rewiring of the Two'er filaments.

The receiver uses a 6U8, the triode half as a super-regenerative detector, the pentode half as an RF amplifier. The regeneration pot on the rear apron controls either the Two'ers detector or the new 6 meter detector. In my unit, setting the pot on 2 meters proved to be satisfactory on 6 also. The Two'er detector plate choke is now common to both bands as is the audio section.

The triode half of a 6BA8 function as a third-overtone oscillator to drive the pentode half which doubles to 6 meters. This allows the use of 8 mc crystals. I have found this transmitter to be quite adequate for local work. The Two'er audio section supplies modulation in transmit.

Changes

The addition and changes were done in four parts.

PART 1 Filaments and filament switch.

1) Add the dpdt slide switch between and below the Two'er tuning capacitor and Tx/Rx switch. Be sure this switch will clear the variable capacitor and the outside case.
2) Wire the Two'er filaments (as shown in

1. 73, March 1963, page 32. *A Six and Two Portable.*

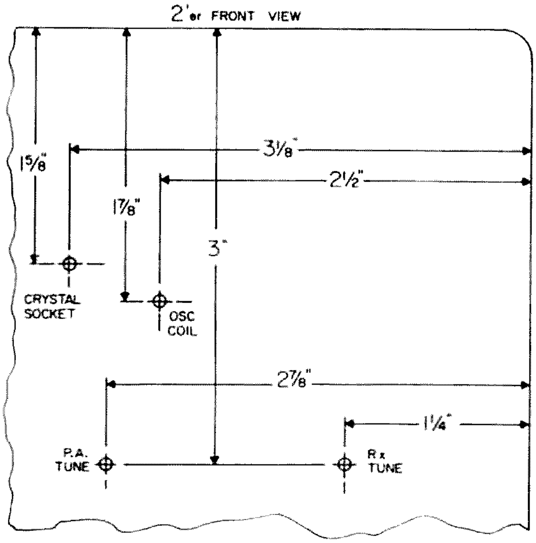
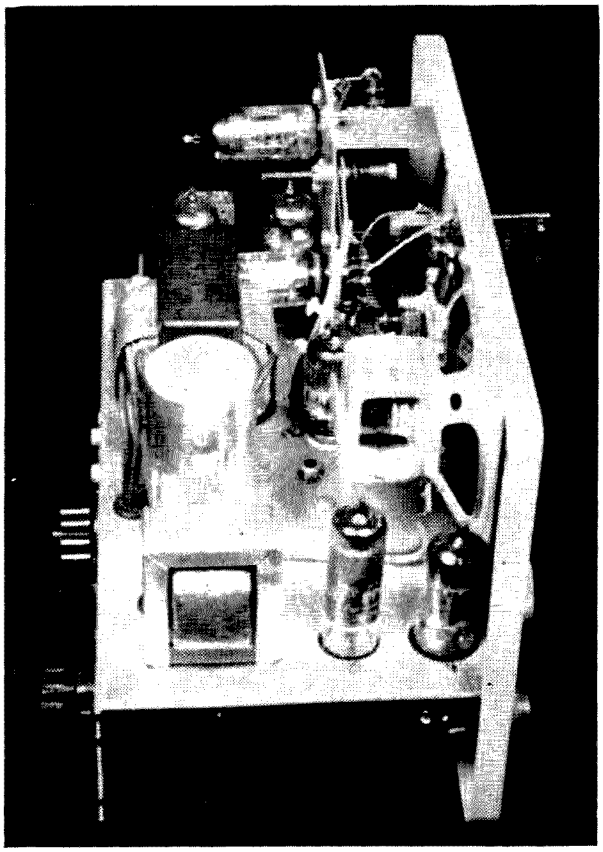


Fig. 2. Upper front panel additions to the Two'er.

Fig. 1) to the switch. The 6 meter filaments will be added later.

PART 2 Tx/Rx switch, antenna jack, and power supply.

1) Move the wire from lug 2 of switch **Z** to lug 1 of terminal Q. (use longer wire)
2) Remove the wires from lug 3 of switch **Z.** One wire goes to lug 3 of capacitor I; remove this wire completely. The other wire goes to lug 3 of terminal AA; this wire now will go to lug 2 of terminal S.
3) Remove the output detector diode, terminal F, jack G, and associated wiring. Mount the type antenna fitting you intend to use in the vacant hole.
4) Add a heavy wire from lug 3 of switch Z to the new antenna fitting. Keep this wire away from the chassis.
5) Replace R14 with a 4 H 100 ma choke. Move C31 and C32 to make room for the choke.
6) Change R15 to a 2.2k 2W.



Top view of the Twixer showing the subassembly in place.

PART 3 Upper front panel additions.

1) Since most hams will be using junk box parts, **Fig. 2** only shows where the component should be centered.
2) Drill the necessary holes and mount the components (except the Receiver variable tuning capacitor).
3) See Fig. 4 for details on the receiver tuner. Mount the receiver variable.
4) Install L11 just above and behind terminal capacitor, the other end goes to C15 in the Two'er.

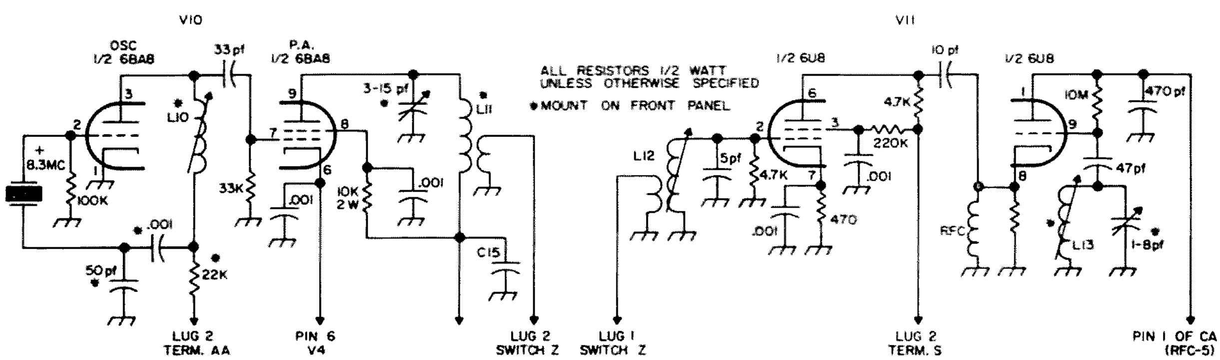
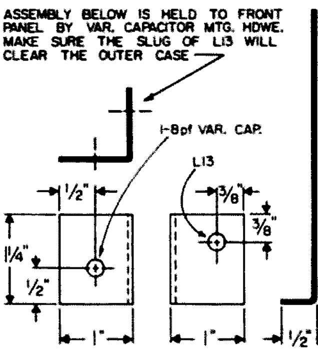


Fig. 3. Schematic of the added six meter components. Cathode resistor of the 6U8 is 470 ohms. L10 is 25 turns #28 enamelled of ¼ inch iron core form. L11 is 7 turns #16 tinned, ⅜ inch diameter, spaced one turn. Link is one turn #20 insulated. L12 is 6 turns #28 enamelled on ¼ inch iron core form. Its link is 1 turn #20 insulated. L13 is 6 turns #28 enamelled on ¼ inch iron core form. **RFC is two layers** #28 enamelled close wound on 3.3 k ½ watt resistor.

5) Install the .001 μf capacitor at L10. Also run a 22k resistor to lug 2 of terminal AA.
6) Run the other end of the .001 μf capacitor to the crystal socket. Also put in the 50 pf capacitor.

PART 4 New subchassis.

1) Make the new subchassis as shown in Fig. 5. The ½ inch lip will have to be notched to fit around V4. The panel should be bolted in 1⅞ inches from the Two'er front panel, after it is wired.
2) Install sockets for V10 and V11.
3) Wire up the sockets. All leads going to front panel controls, or to the Two'er circuit, should be left long enough.
4) Put the panel in place and drill convenient holes for mounting. Also drill holes for running the wires from this assembly through the Two'er chassis.
5) Make a strap to secure the upper end of this assembly to the front panel.
6) Secure all the loose leads from the new assembly (see Fig. 3).



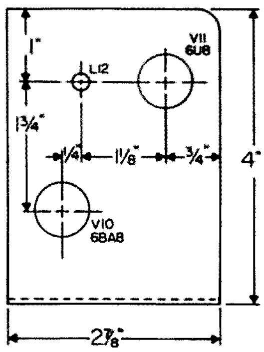


Fig. 4, left. Details of capacitor and coil tuning assembly.

Fig. 5, right. Details of the new subassembly. Front view of the Twixer.

TESTING

1) Put the filament switch in the 6 meter position. Turn on the power. If the filaments light, and there is no smoke, adjust the Two'er regeneration control of the regenerative hiss. Adjust L13 to get the tuning range to 6 meters. On a weak signal peak L12.
2) Plug a 8 mc crystal for 6 meters into the new crystal socket. Put the Tx/Rx switch in the Tx position. Adjust L10 for maximum output (use a grid dipper in the diode position) at 24 mc. Adjust the 3-15 pf capacitor for maximum 50 mc output (use a small pilot lamp for a dummy load).

That's it. You now have a Twixer Two'er.

. . . WØHMQ

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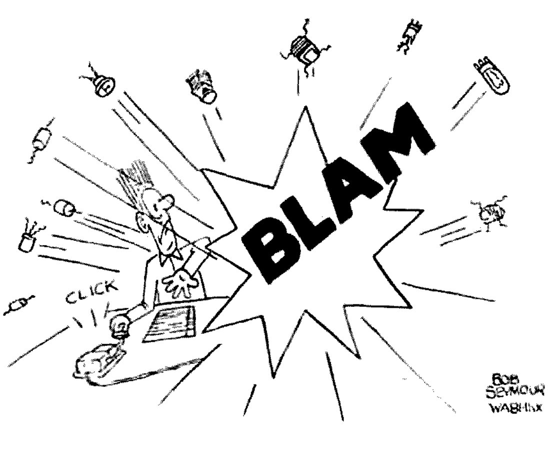
A Line About Line Noise

The other day the family left me alone with the house and it was peaceful. I sat down at the rig with full intentions of enjoying a few hours of DX-chasing or rag-chewing, whichever seemed most probable. With the earphones in place, the warmed tubes of my hearing aid greeted me with the loudest racket I have ever heard. My S-meter spun over to S-9+ without a signal coming through. Needless to say, my spirits dropped to rock bottom and my relaxation was shattered. After a few choice invectives, I started to turn to a new mystery book. However, having had this experience before, something inspired me to start researching.

The first reaction was to yank out the antenna lead to the receiver. When this was accomplished, the noise stopped. Here was my assurance that the interference was probably generated by a source outside of the shack. I knew what I could do: call the power company. The power company has a group of trained men whose job is to track down radio interference emanating from their installations and they usually locate the trouble. However, I also had learned another thing: it is much better to tell the power company approximately the location of the noise or where I thought it was being caused. Such information can speed their search immeasurably. This meant I must embark on a small transmitter hunt with my mobile gear. Tracking down line noise is no art and takes little skill. It takes patience. It can be done with a mobile amateur receiver or with a transistorized broadcast receiver, but the latter is not as sensitive, does not have an S-meter and is not too directive. Consequently, it is better to use mobile gear for this work.



Last winter I was cursed with a noise which was intermittent—loud crashes every few seconds—as if two wires were striking together or as if a branch was hitting a live wire every time a gust of wind came along. It was a dark, blustery, cold and snowy night, but I was an angry ham and as long as I could not have fun indoors with the rig where I belonged, I bundled up and faced the storm. In my mittened hand I clutched a broadcast receiver which led me directly to the feed-line coming down from a cubical quad on the

roof of a neighbor's house. This, I was aware, was not connected to his receiver or transmitter. Each time I placed the receiver against the coax, I received energetic blasts of noise. Yet I knew that there was no power up there to generate noise—even static charges could not be responsible for it. Then I discovered the same racket on my own feed-line. The noise was being picked up by the antennas and coupled through the feed-line to the BC receiver. I quit and returned to another mystery novel. The sequel to the story is that after having been plagued for months by the same noise in various degrees of strength, the power company came out and removed from a high wire, a piece of baling wire which had been used to tie up newspapers. The news boys had tossed it over the lines several blocks from my QTH.

There you are—look for bailing wire!

To assist me in obtaining the general direction of the noise and to save gasoline at the outset, I always peak up the signal with my beam. In almost every case, it shows definite directivity. Then I scramble out and light off with the mobile gear, drive down the street in that general direction watching the S-meter rise or fall. It is not long before I locate a place where the noise reaches a crescendo. Nevertheless you can be fooled. Line noises have a tendency to have peaks and nulls as you travel along their path. The interfering signal also has a propensity to travel down the ground wires of the poles and show up loudest at a spot a long way from where it is generated. Then you really have a problem. The power company men are the only saviors in such cases.

Now comes the situation when you pinpoint the noise, not on the power company's lines, but in and around a private dwelling. Here, like TVI, diplomacy is necessary. The noise might be interfering with the TV in that house and in many other houses thereabouts and is being blamed on you, the nearest ham. So it is always better if the power company makes the call for you. They will as a rule. The nastiest situation of this nature was the noise which had been plaguing a well known ham for months. The noise always came on at a certain time each morning, just when DX was at its best. The power company informed the ham that they had traced it to a certain address and had ascertained that it was a heating pad. The heating pad belonged to a lovely old lady who suffered from arthritis. What to do? The lady couldn't be asked to forego the use of her pad. So I suggested that a letter be

written to the manufacturer. Sure enough, a new heating pad arrived in a short while. But, how embarrassing! That very day the power company men informed the amateur that they had discovered a cracked insulator which was the source of the disturbance. At the hour the noise commenced, someone (possibly the lady) always pulled a load from the line and the insulator commenced to arc. There was a new heating pad and no noise!

One must never forget the electric tool—the electric razor (I hate them, but many people would not use anything else)—the vacuum cleaner,—the mix-masters, the electric drills and saws—and the fellow who always tunes his car when the DX is hottest. I am still trying to get a cure-all for vacuum cleaners, as they, of all the above, stay on the longest in hands of a meticulous housekeeper. My neighbor's vacuum cleaner makes more noise than my wife's and that is bad enough in some parts of the house. In other parts of the house I do not hear it. It depends on the wiring. What to do? Even the power company says trial and error—cut and try—sometimes a line filter, sometimes a capacitor, but each is ad hoc. You can't argue with a neighbor over that and as for the XYL . Please clean when I am at work. Thanks.

The power company volunteered a good one about a disturbance which bothered TV, BC and all the neighbors for a good distance around. After a long chase along their wires, after visiting various homes where the noise seemed strong, one power company man pulled a fuse in a private house and the noise ceased. Then, ascertaining that nothing was plugged into the particular line, he put the fuse back into its socket and the noise arose once more. Only because someone, at that moment, rang the *door bell* was any thought given to that little noticed, but important household appliance. Inspection showed, when the bell transformer was located, that it was in deplorable condition. It had been arcing to its case for so long that it was covered with soot—and it had not actually shorted out! So watch out for the door bell transformers.

I had a really fine noise when I lived in an apartment. I was ready to take an oath that a bootlegger was operating in or near the building and was sending CW with a raw note. I do not recall how I made the discovery, but the culprit was a cheap tropical fish tank thermostat. It would keep coming on and off with very fine rhythm, and sending out a strong signal through the lines.

Other annoyances can be butter conditioners in refrigerators, the machine in the store down on the corner which keeps the peanuts warm, a cheap house fuse (a lot of people use them), and a loose connection in a light cord. There is hardly any use in mentioning neon signs and fluorescent lights because they should be the first suspect if present. Diathermy once was a great cause of concern when considering interference but lately it has been tamed and properly shielded. Some TV sets can cause interference, but that source is very rare.

The power company tells me that in areas close to salt water the spray and the mist can deposit a coating on insulators which will then produce a corona. Furthermore, atop certain poles are large knife switches for power company use and they become crusted with salt and dust and soaked with moisture. When that happens a resistance is built up between the blade and the other element of the switch and arcing occurs.

But don't get caught off guard—one day I couldn't hear a thing on 20 but a raucous roar. I did everything but turn off the final. When I did that, the noise abated. I turned it on and in a few minutes it was there again. It wasn't the blowers, but it was a loquacious tube. I replaced the tube and the noise was in the past. A faulty TR switch can also cause you no end of annoyance.

I have found that the power companies are always willing to help you if you keep after them. It is human to travel the easiest path. So it may require several calls. It may take a letter to the local FCC office to stir them up. One amateur near me made a log of the number of times and the dates he called the power company without any response. Suddenly he received a landline call that they were coming to his area with a van load of gear from the state capital. That did it. The noise stopped before they arrived. The visit was repeated three times until they found the culprit. The old gag about the toothache vanishing as you approach the dentist's office.

The big big difficulty is that the power company men work when I work and you work and everybody but the night shift works. Day time! The noise generally comes at night when dampness settles and homes draw a heavy load. That is why it may take coaxing to get the power company men to acceed to your schedule and the noise schedule as well. Don't give up! The criminal may give you trouble, but it will eventually be silenced.

In summation, first try to locate the source of the line-noise. Then call the power company. If one call does not bring results or a representative, make several calls. They may be very busy. If that fails, contact the nearest FCC office explaining the situation. They may contact the company or come out with their own equipment. The most important thing is not to take line-noise as a matter of course. Make every attempt to have it tracked down. It is not something which should be accepted as inevitable. Good hunting!

. . . W4NJF

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Assembling the Sideband System

In the previous articles of this technical series on sideband, we have examined virtually all the "building blocks" that go to make up a sideband system, in either the transmitter or the receiver. Now it's time to see how these blocks go together to form a complete system, as well as to find out how to test and measure the performance of the finished system.

First, though, let's review the "building block" concept. It's an idea which is becoming more and more popular with professional designers, since it makes their job so much simpler. Basically, any electronic circuit (no matter how complicated) can be thought of as a "black box" with its input, output, and supply voltages specified. Given a large enough number of types of these "black boxes," a designer can put together any type of system by simply using the boxes as building blocks, joining the output of one to the input of the next and arranging them by function so as to come up with the system he wants.

All of us do this to some extent in our stations; the transmitter is one building block, the microphone another, the antenna still a third, and the receiver a fourth. We choose what we like for each of these four blocks, connect them all together properly, and come up with a station.

Similarly, the specific circuits discussed in earlier articles in this series can also be considered as blocks, and hooked together in a nearly infinite number of ways to provide the sideband station you prefer.

In using the building block concept, two factors are of extreme importance. Whenever two blocks are joined, they must be compatible both in signal level and in impedance. Thus you wouldn't connect a coax-output-only

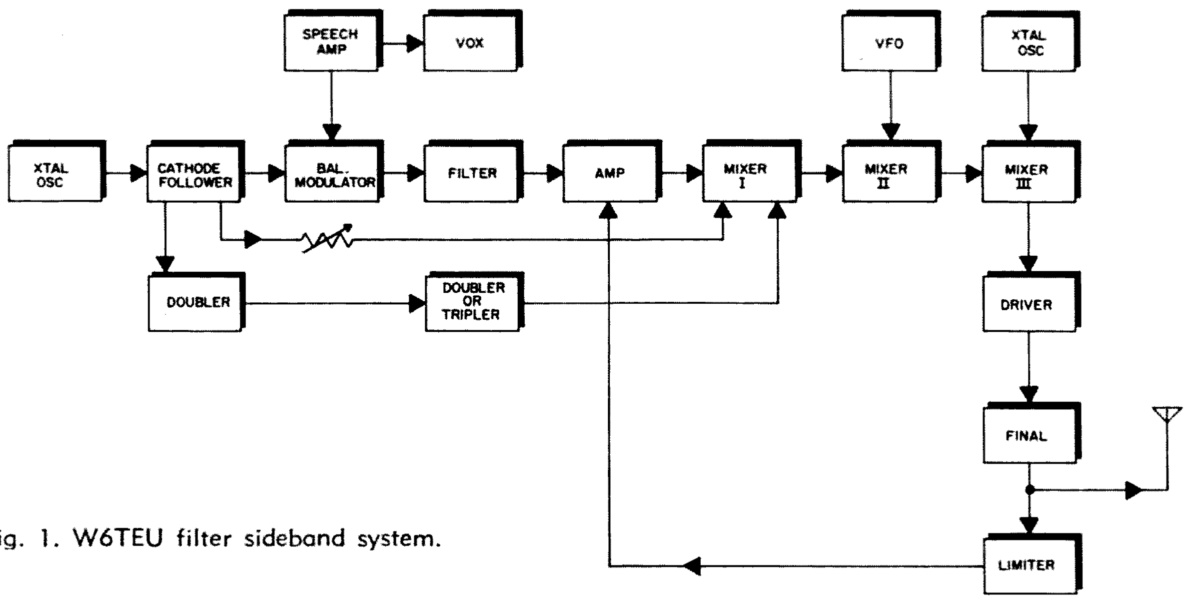


Fig. 1. W6TEU filter sideband system.

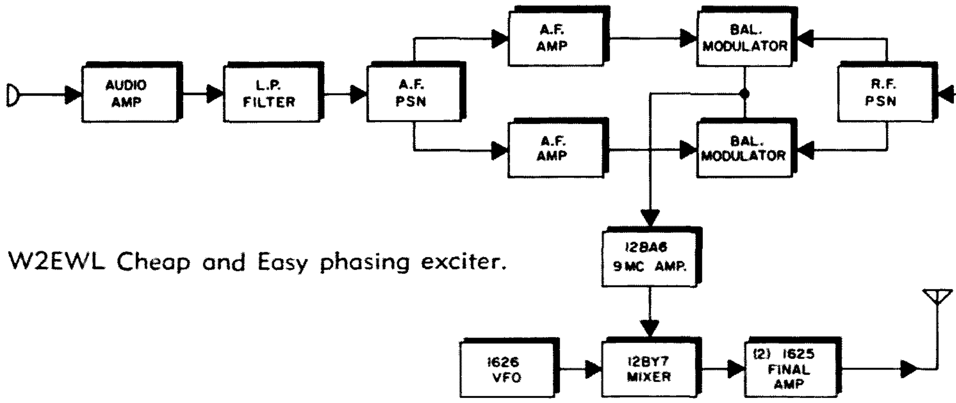


Fig. 2. W2EWL Cheap and Easy phasing exciter.

transmitter directly to twinlead; you'd put an antennna tuner (another block designed specifically for matching purposes at each end or "interface") in between to make everything work.

Most of the circuits discussed so far are fairly compatible; input and output requirements of each are described in the original discussions and won't be repeated here. A few just don't work out right without matching blocks between.

To show how the blocks can be put together into a number of different systems, let's look at some of the more popular homebrew sideband systems from the recent past, as well as at one commercial transmitter.

The W6TEU filter system

A good starting point is the W6TEU "Sideband Package" first described in the June, 1958, issue of *QST*. A block diagram of this unit is shown in **Fig. 1** (for the schematic, see the ARRL manual *Single Sideband for the Radio Amateur*—or draw your own by filling in the blocks with the circuits from previous articles in this series).

The block marked "speech amplifier" is a conventional audio amplifier such as that used in any modulator, giving approximately 30 volts peak audio output from a crystal mike (but only about 2 volts are normally used—the rest is reserve). The resulting audio feeds a two-diode balanced modulator.

The balanced modulator also receives rf input from a 450 kc crystal oscillator, through a cathode follower used for impedance transformation. An unusual feature of this circuit is that the crystal oscillator output is also doubled, then passed through a stage which can be switched to either double or triple, giving an output frequency which is either 4 or 6 times that of the crystal. This is used later to provide choice of sidebands.

Output of the balanced modulator goes through a 455 kc filter, which may be either a mechanical or a crystal lattice type (W6TEU used a crystal lattice). The filter output is upper sideband, and passes through a class A voltage amplifier before reaching the first mixer.

The other input to the first mixer is the 4x or 6x crystal frequency mentioned earlier; the output of this mixer is always at 5 times the original crystal frequency. Since the 455 kc input was upper sideband, the output will be upper sideband if the injection is at 4x, and will be inverted to lower sideband if the 6x injection is used. This trick provides a choice of sidebands with no compromise of filter characteristic.

Carrier output from the cathode follower is also provided to the first mixer through an "injection" potentiometer, to allow AM operation if desired.

The 2250 kc output of the first mixer then goes to a second mixer, where it is heterodyned against the output of a VFO operating in the 5250-6250 kc region; the output of this mixer is between 3 and 4 mc, usable on 75 directly and capable of being heterodyned again to higher bands. This heterodyning occurs in the third mixer, where a crystal oscillator provides the transfer signal.

Output of the third mixer goes through a chain of linear amplifiers, at ever-increasing power level, to the antenna. A bit of outgoing

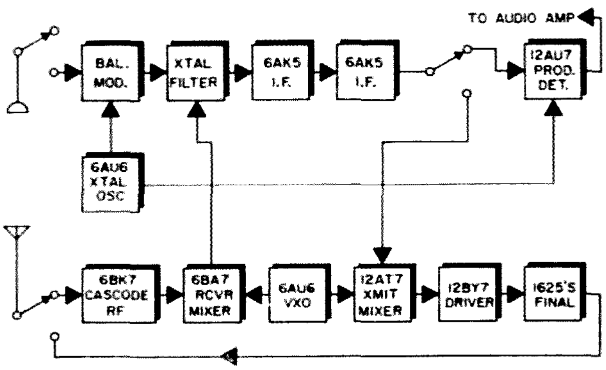


Fig. 3. W3TLN SSB transceiver.

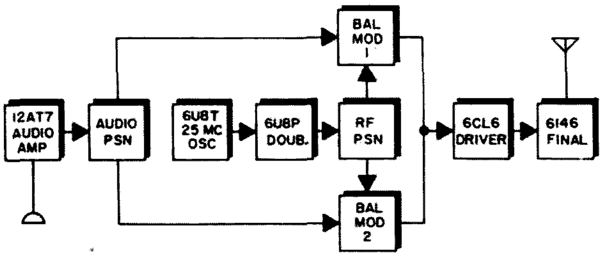


Fig. 4. The Little Feller.

signal is sampled and used for automatic gain control, to prevent limiting in the linear amps.

The W2EWL phasing exciter

This exciter is a filter type, and has been highly popular with those liking filter exciters. One of equal popularity among the phasing set was W2EWL's "Cheap and Easy SSB," originally described in QST for March, 1956.

The block diagram of this unit appears in **Fig. 2**; the schematic is in the ARRL publication mentioned earlier.

Like the W6TEU rig, this uses a conventional audio pre-amp without about the same characteristics; it feeds a cathode follower for impedance matching, and the audio then goes through a low-pass filter to remove everything above about 3 kc before reaching a commercial phase-shift network.

Output of the phase-shift network feeds a pair of triode amplifiers, which in turn drive (through transformers) a four-diode balanced modulator.

The rf input to the balanced modulator originates in a 9 mc crystal oscillator, passes through an rf phase-shift network, and then meets the audio in the balanced modulators. A tank circuit in the balanced-modulator output does the phase addition and cancellation which gets rid of one sideband, and a voltage amplifier brings the wanted sideband up a bit in level before it reaches the mixer.

The mixer's other input is from a VFO operating near 5 mc, and mixer output goes to a pair of 1625's (or 807's) which feed the antenna directly.

The SSB transceiver

The great similarity between a SSB transmitter and a SSB receiver has prompted several designers to combine the two into a single system; quite a number of SSB transceivers are now on the market. One of the original designs was that by W3TLN, described in June, 1959, in QST. **Fig. 3** shows the block diagram of this unit.

Audio in the W3TLN unit comes from a carbon mike, eliminating the pre-amp used in the other two systems examined. It goes directly to a bride-type balanced modulator, which gets its rf from an 8553 kc crystal oscillator. Output of the modulator goes to a filter which passes 8550-8552.7 kc, and the sideband which gets through the filter is then amplified by two class A voltage amplifiers.

In the transmit position, output of these amplifiers goes to the transmitting mixer, which receives its other input from a variable crystal oscillator which can tune some 50 kc on 15 meters. Mixer output feeds a 12BY7 driver, which in turn pushes a pair of 1625's which are hooked to the antenna.

In the receive position, incoming signals go through a cascode rf amplifier into the receiving mixer, which also is fed by the VXO; output of this mixer goes to the filter input, and the output of the amplifiers following the filter is switched to a product detector which gets its BFO signal from the 8553 kc crystal oscillator.

Switching from transmit to receive is done primarily by supplying or removing plate voltage from the various tubes; only two signal-carrying leads are switched, one at the antenna and the other at the *if* amplifier output.

The Little Feller

One of the simplest of all single-sideband transmitting systems is Lester Earnshaw's "Tucker Tin Two" apparently first described in "The Sidebander" and later picked up and modified by a number of other people. One of the most interesting versions of this system was "The Little Feller," first put together by W5ORH and reduced to duplicatable form by W5BCS, and described by them jointly in the November, 1962, *VHF Horizons*.

Fig. 4 shows the block diagram of "The Little Feller," and you'll notice that it uses only four tubes (outside of the power supply) to give SSB output in the 50 mc band.

Audio passes through a 12AT7 preamplifier, although a carbon mike is used (purpose of the carbon mike is to reduce highs without resorting to an audio filter). It passes through a homebrew phasing network consisting of two capacitors and one resistor, then goes to a pair of two-diode balanced modulators.

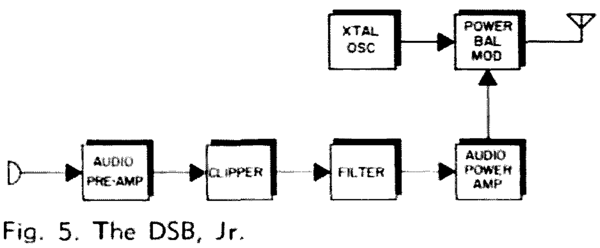


Fig. 5. The DSB, Jr.

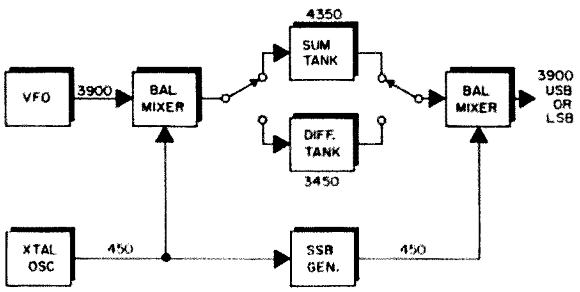


Fig. 6. Getting USB or LSB at the VFO frequency.

The rf for the balanced modulators comes from a 6U8 oscillator-multiplier, which uses a Robert Dollar circuit to get 25 mc output from the triode half with an 8.3 mc rock, then doubles in the pentode. An RC rf phasing network is used between the multiplier and the modulators.

SSB output from the common tank circuit of the modulators is amplified in a 6CL6 driver, operated class A, and then goes to a neutralized 6146 output stage. And that's all there is to it.

Double sideband—the DSB, Jr.

Double sideband is just about as simple; the G-E Ham News "DSB, Jr." circuit also used four tubes to get comparable output. The block diagram appears in **Fig. 5**, and is applicable to almost any DSB system.

Audio passes through a single stage of amplification, and is then clipped and filtered to increase the average power level. Next, it goes to a low-power (less than 1 watt here) power amplifier, which drives the balanced modulator.

RF for the balanced modulator input comes from a triode crystal oscillator, operating at final output frequency. The balanced modulator itself is of the active type, using two power-output tubes; this is the biggest difference between DSB and SSB so far as the system goes. Output from the balanced modulator goes directly to the antenna, and you have a functioning DSB rig.

Many variations of these five systems are possible; in addition, there's nothing to stop you from going back through our preceding articles and putting together the blocks in your own way, to come up with still a different system. At least one fellow has tried following a phasing system with a filter, to get all the advantages of both techniques (he says it works fine).

The sideband VFO

At this point, you have a complete sideband transmitting system—but you still add quite a few conveniences to it. Things such as VFO control, VOX circuits, and T-R switches make life much easier.

Common usage of the VFO in sideband operation is by the heterodyne technique; this minimizes any frequency instability of the VFO, an important consideration when you consider that 50 to 100 cps is the maximum drift allowable in sideband.

Phasing rigs generating their sideband at 9 mc usually use a 5 mc VFO, so that the VFO output may be *added* to a 9 mc upper sideband to get USB output on 20 meters, or *subtracted* from the same 9 mc signal to get LSB on 75.

Another VFO technique, passed along by W5QMI in *QST* several years ago, uses two balanced modulators to give the choice of USB or LSB, at the VFO output frequency. A block diagram of the technique is shown in **Fig. 6**.

From the VFO, the rf signal is fed to a balanced modulator along with the crystal frequency of the sideband exciter (which may be either phasing or filter, and at any frequency). The output circuit of this balanced modulator can be switched to either the sum frequency, or the difference. This sum or difference frequency, in turn, goes to another balanced modulator together with the SSB output of the exciter. Output of the second balanced modulator is on the VFO's original frequency.

If the difference frequency was chosen from the first mixer, the sideband output will be the same as that from the exciter. If, however, the sum frequency was chosen, the sideband will be inverted so that lower becomes upper and vice versa.

As originally described, the VFO was on 3900 kc while the exciter was on 450 kc; any frequencies will work, however, so long as

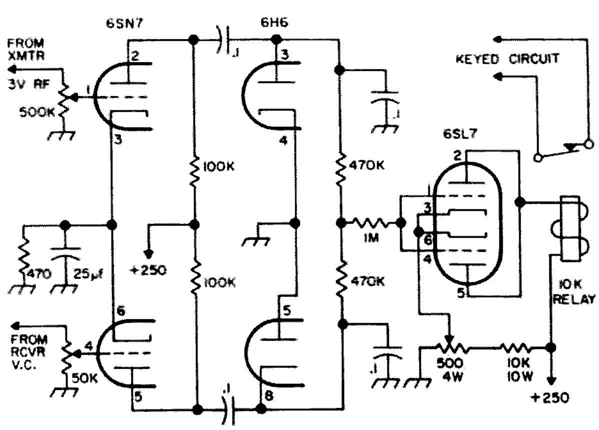


Fig. 7. Simple QT VOX.

they are separated properly to avoid image troubles.

VOX

To many operators, SSB operation and voice control are synonymous. Actually, either can be used separately, but most of the advantages of voice-control or VOX operation can be used to their fullest only with a suppressed-carrier system. On the other hand, AM does not sound so good with VOX.

Many VOX circuits have appeared; basically, all of them consist of a way of using the audio from the microphone to either trip a relay or fire a keying tube, so as to turn the transmitter on and the receiver off whenever the microphone is receiving any sound.

The earlier circuits couldn't be used with a loudspeaker, because the mike had no way of telling where its sound was coming from. Later, however, cancellation or QT circuits were developed to allow VOX and loudspeakers to live together.

One of the simplest such VOX units was developed by W6IBR, and uses only three twin tubes plus a relay. The circuit is shown in **Fig. 7.**

Audio sampled from the transmitter is amplified in half of the 6SN7, while some from the receiver goes to the other half of this tube. Outputs of both tubes go to half-wave rectifiers (the two halves of a 6H6) which are connected to give DC outputs of opposite polarity. The summed outputs of the rectifiers, in turn, fire a keyer tube, the 6SL7. When no output is being received from the transmitter, the keyer tube conducts and holds the relay closed. By proper balancing of input level controls, this condition can be made to hold true even for loud signals from the receiver. But when you talk into the mike, the keyer tube is cut off by negative voltage developed through the "transmit" rectifier, and the relay drops out, putting the transmitter on the air.

A number of other VOX circuits have appeared in the literature from time to time; the ARRL publication mentioned earlier contains a wide selection of them.

T-R switches

With a VOX circuit (as well as for break-in on CW, which is a bit outside our scope here) you must have virtually instantaneous changeover of the antenna from transmitter to receiver. Antenna relays just don't operate fast enough; the situation calls for an *electronic* switch with no moving parts.

Such a switch is called a T-R switch, and

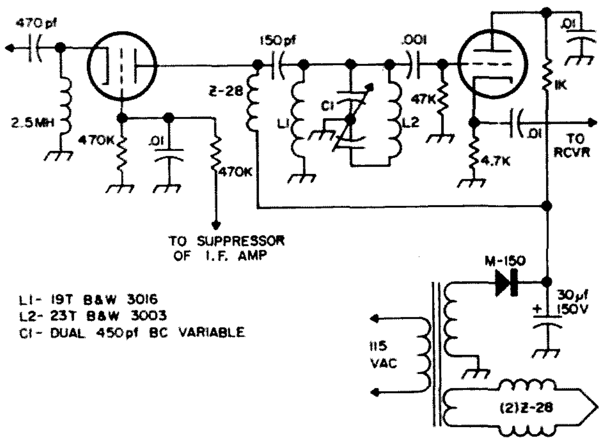


Fig. 8. Electronic T-R switch.

like VOX circuits, quite a few have been designed.

Several of the most popular have been built around grounded-grid triode amplifiers with high-valued grid-leak resistors, bypassed to ground. Under normal received signal conditions, these amplifiers give some gain (with a tuned plate circuit). However, when hit with several volts from the transmitter, the grid draws current and the resulting current flow through the big grid-leak resistor cuts the tube off. You can even pick off a bit of this cut-off voltage through an isolating resistor and use it to mute the audio of the receiver, if you like.

A typical schematic of such a circuit, adapted from a design by W3LYP originally published in *QST* for October, 1957, appears in **Fig. 8.** The original circuit operated up to the kilowatt level with very low SWR, but only with RCA tubes. Other makes were unable to take the high rf voltage between cathode and filament. The modifications included here are intended to make any 6BZ7 usable, as well as to allow for receiver muting at the same time.

All of which brings us around to the final subject on our agenda: instrumentation, adjustment, and testing.

Instrumentation

Any transmitting system requires some instrumentation. FCC regulations require us to log input power used, and most of us want to be able to tune up for maximum output

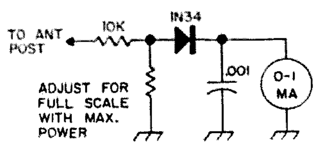


Fig. 9. Crystal diode voltmeter.

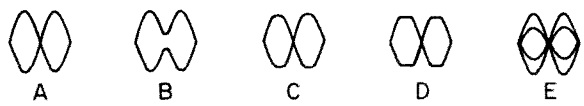


Fig. 10. Typical two tone patterns.

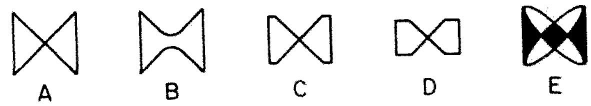


Fig. 11. Twin trapezoid (bow tie) patterns.

power as well. In addition, with a sideband system it's essential to adjust it for maximum linearity (this is important in AM too, but not so well realized). All of these aims require different types of instruments to be hooked into the circuit.

Input power is easy to determine with a plate milliammeter and a voltmeter across the final power supply; with suppressed-carrier systems, the FCC has ruled that the *official* power input is the product of the voltage and the highest current read on the meter during operation, with the further specification that the milliammeter used have a time constant not greater than ¼ second (this is true of almost all common milliammeters). Thus if you run 500 volts to the final and the current meter occasionally kicks up to 250 ma, you're running an official 125 watts input.

Output power is measured most simply by some sort of rf voltmeter connected across the feedline. A reflectometer type of SWR bridge, in the forward-power position, is excellent. So is a crystal-dioxide voltmeter (isolated by a resistor to avoid harmonic troubles) across the rf output jack, as shown in **Fig. 9.** With either of these, tune for maximum meter swing with a steady-tone input signal.

Both of these types of instrumentation are necessary for day-to-day operation, but for initial tuneup of a sideband rig—*and* most helpful also in routine operation—an oscilloscope of some type is a must.

The reason for this is that a meter can tell you only how much power is going in or coming out; it can't tell how distorted the power is or isn't.

The sideband scope need not be elaborate; several simple varieties have been described in the past. Most service-type scopes can be adapted for SSB waveform examination by connecting a length of twinlead to the vertical deflection plates of the CRT, then forming the other end of the twinlead into a two-turn loop (splitting the insulating web down the middle first) and coupling this loop to the final amplifier tank.

For some sideband tests, a pair of linear envelope detectors can be used, and then no rf appears on either scope input. Circuits for these detectors will be discussed a little later.

All sorts of sideband tests can be run with the scope. The most common, often used for checking general adjustment of the linear amplifier, is the "two-tone" test.

Testing with the scope

To perform this test, feed an audio signal of about 1000 cps into the mike input, being careful not to overload the audio section of the rig. Unbalance a modulator slightly to inject some carrier, so that two tones separated by about 1000 cps go through the final.

In a filter rig, this is done by first unbalancing the modulator so that about half-power carrier goes through. Then the audio is fed in, and increased in level until the negative peaks on the scope just meet at the center of the display.

In a phasing exciter, leave the carrier balance alone but disable the audio input to *one* of the two balanced modulators. Feed just enough audio tone in to get a usable pattern.

The "two-tone" test can show you the point of peak limiting of your final, can show the proper bias point, and can reveal parasitics also.

Typical patterns of this test are shown in **Fig. 10.** The first pattern, A, is the ideal. Pattern B shows the effect of too much bias, while pattern C is what you'll get if you're overdriving. Extreme overdrive gives pattern D, while parasitics show up as in pattern E.

For phasing rigs only, a more informative variant of the two-tone test is the "twin trapezoid." This is also very useful with DSB transmitters. The test setup is identical with that of the two-tone test except that the horizontal sweep signal for the scope is taken from the audio oscillator rather than from the scope's internal sweep oscillator.

Patterns to expect with the twin trapezoid (sometimes called bow-tie) test appear in **Fig. 11.** The ideal pattern is shown at A; B shows the effect of too much bias. Pattern C is slight overdrive, while D shows extreme overdrive. If the pattern shown at E appears, you have phase shift in the system and

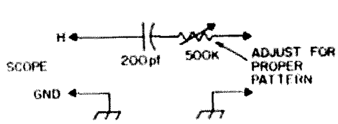


Fig. 12. Phase shift equalizer.

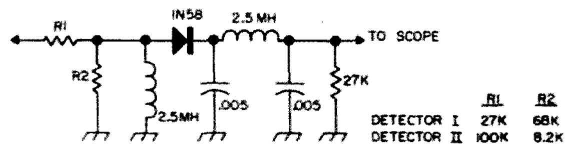


Fig. 13. RF detector. See Fig. 14.

should connect an equalizing circuit such as that of **Fig. 12** betwen the oscillator and the scope; adjust for a clean pattern.

Linearity tests

To check for perfect linearity the most informative technique is to sample a little rf SSB ahead of the amplifier, and a little more after it, then compare the two samples. This is easily done with a scope and two linear detector units.

Fig. 13 shows the circuits of the two detector units, while **Fig. 14** shows the test setup in block-diagram form. Such a setup can be permanently wired into the system, coming out on two sets of leads to tie into the scope.

To start the test, feed some audio into the transmitter and connect the scope into the circuit. Set horizontal input selector to "external," and adjust both vertical and horizontal gain controls on the scope to get a straight line at a 45-degree angle (if possible). If you can't get the line straight, adjust for a 45-degree angle at the straightest part; if the line opens up into a loop, hook up the equalizing circuit of **Fig. 12** and adjust to get a line.

Now you can either use the single-tone sine-wave input, or merely talk into the transmitter. So long as everything is operating perfectly, you'll continue to get the straight line as shown in A of **Fig. 15,** although length of the line will vary as you talk (and it will shrink to a dot when you aren't talking at all).

Improper operation of the amplifier is indicated by the other patterns of **Fig. 15.** Improper tuning of the driver can give the pattern shown at B (which may come out upside down on your scope due to phase reversals). Pattern C indicates non-linear operation due to incorrect bias. Pattern D shows overdriving of the final. This test, incidentally, can be used for talking up to the absolute legal limit with no fear of harming the tubes while testing. It was first described by W8QNW in CQ for March, 1958.

So far, we've been talking about operating tests mostly; however, initial tune up is a most important testing step, so let's take a little time to see how it's done on the various types of rigs.

Tuning the filter rig

Simplest of all types to tune initially is the filter rig. We'll assume that all the stages are operating and produce at least some output, approximately of the nature you intended. This is initial tune-up, not de-bugging.

First step is to key the rig and insert a little bit of carrier. This injected carrier is used to tune the final stages for maximum output power just as if it were a CW rig or an AM phone affair.

Now remove the carrier injection and see if the output drops to zero. If not, adjust the balance of the modulator until it does. You should have no detectable output at all in the absence of speech input.

When you have the carrier completely out of the way, you can proceed to test linearity of the final. Adjust bias for best linearity, being certain not to end up with a value of resting plate current which is too high for the tubes. If you do, make the best compromise you can. You'll find the loading to be another important factor; underloaded linear amplifiers are seldom very linear. One quick way to find a starting point is to inject some carrier, tune for maximum output, then load up (redipping for resonance every time) until output drops 10% from maximum. Remove carrier and adjust bias for best linearity, then touch up the loading.

The DSB rig

Next simplest to tune is the DSB rig. Procedure is essentially the same; first inject a little carrier by unbalancing the modulator and tune for maximum output, loading a little heavier than the point of maximum smoke, then re-balance the modulator for minimum carrier.

Then hook up a scope for the twin trapezoid test, and adjust bias for the best crossover characteristic. When you get it, you're ready to go.

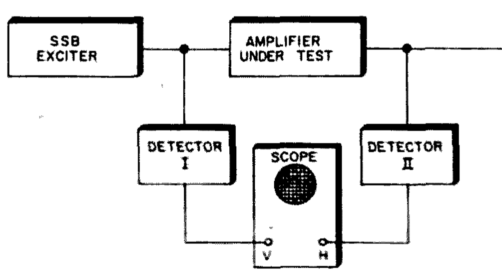


Fig. 14. Linearity test set up.

Fig. 15. Linearity test pattern.

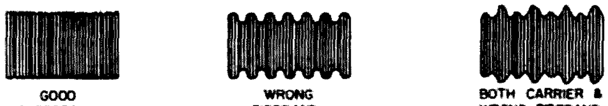


Fig. 16. Carrier and sideband suppression.

The phasing system is harder

Most complicated of all to initially tune is the phasing rig. On it, you have at least four and often more special adjustments, in addition to all the normal rf tuning controls.

Quickest way to tune one of these is to follow the same initial procedure, to the point of having increased final loading for a 10% drop in output, then simply look at the output rf waveshape with a single tone audio input. The waveform of the audio should be free of harmonics, because they will give you troubles.

If everything is working right, you'll see a band of light with perfectly smooth top and bottom edges on the scope. This indicates suppression of both carrier and undesired sideband by more than 30 db. More likely, you'll find ripples on the pattern. If the ripples look like two different frequencies are present, you have both carrier and "wrong sideband" in the output. If they seem to be of only one frequency, the carrier is probably satisfactory but the other sideband is still showing up. Typical patterns for all three cases appear in **Fig. 16.**

Note that ripples due to carrier are twice as wide as those due to "wrong sideband." This tells you which adjustment needs touching up.

The controls and what they do are as follows: the rf phasing control, somewhere in the rf phase-shift network, is one of two (sometimes three) which affect sideband suppression. The other two are the af balance control, usually found in the circuit of the amplifier following the phase shift network, and the af phasing control, ahead of the PSN. The carrier balance controls, in each of the two balanced modulator circuits, control carrier suppression.

When you're looking at the output waveshape, it's easiest to adjust the carrier balance controls with no audio applied, working for zero output from the exciter. Then apply audio, and follow a round-robin technique with the other controls to minimize ripples on the display.

However, even with all ripples gone, there is a chance that you may have adjusted to put some "wrong sideband" into the signal to cancel out unsuspected 3rd-harmonic output! For this reason, it's always wise to check with a sharp receiver after using the scope for tuneup. The receiver *can* be used instead of the scope, but in the early stages of adjustment is sensitive to overload.

To use the receiver, first tune to the wanted-sideband output signal with the receiver set for minimum bandwidth, and adjust coupling from receiver to transmitter to get a convenient S-meter reading. Then tune down to the carrier frequency, and balance the carrier controls for as close to an absolute null as you can get. Finally, tune on to the "wrong sideband" and adjust the suppression controls for the best null possible here also. Then go back to the wanted sideband and check all the adjustments, just to make sure nothing has gone wrong.

If you can't seem to make the rig behave during any of these tune-up procedures, trouble-shooting is indicated. However, it should be little problem if you have put the system together building-block fashion. Usually the type of misbehavior points to the offending circuit. For instance, balanced-modulator trouble usually manifests itself by an inability to get a carrier null. This may be due to a bad diode, or to a tank circuit pulled far out of resonance by diode capacitance.

In a filter rig, troubles in the filter show up as incomplete sideband suppression. The cure depends largely on the type of filter used. The same symptom in a phasing rig usually comes from the audio phasing section.

Lack of linearity may be due to improper adjustment or to faulty parts values in the amplifiers; however, a rough-sounding final signal may not be due to the amplifier at all as the modulators themselves may be a bit non-linear also. This type of distortion is usually cured by keeping the ration of rf to audio voltage high, or, in other words, operating the balanced modulators at extremely low modulation-percentage levels and making up the gain in the linears later.

By this time, you should have enough data to design, build, test, and operate any kind of SSB system. If you need additional data, the books listed at the end of the first article of this series are recommended. See you on sideband!

. . . K5JKX

Gus Browning W4BPD

Gus: Part IX

At the end of Chapter 8 I was on the island of Mahe with WØAIW, WØMAF, WØUQV and Harvey Brain, VQ9HB where we had all gathered for the purpose of going to either Agalega or Aldabra Islands. The boat had been chartered from Harvey. Plans had been made to have the boat ready for us to depart immediately upon our arrival from Mombassa. But the boat was a long way from being ready to leave. Some of us were at the point of wanting to go back to Mombassa because we discovered that it would be almost impossible to get the boat in condition to depart in a day or so. The Ø boys had a rather tight schedule, as they had to return home by a certain day. As for me, I had no definite schedule, my problem being centered around money. After much talking and work we did get the boat in a more or less seaworthy condition. Harvey went to Temolgee's Store and bought the necessary things we would need. We loaded our equipment on board. The transmitter was strapped down in the hold on a small table and the 'putt putt' (generator) was fastened down on the front of the deck. The cook stove was in the center of the deck with the two 50 gallon drums of petrol fastened down very near it! Macan the cook had his big bag of rice, ole Doc had his deep sea fishing equipment, and Harvey had his black cat. We were as ready to go as we would ever be.

Harvey maneuvered the ship very expertly through the maze of buoys and other obstacles between the short pier and the deep water of the channel. Mike got his deep sea rod out and put a spinner on the line and let it out behind the boat some 150 or 200 feet. Macan got busy with his cooking on the open deck. Now let me tell you about that cook stove thing. Built up on the deck near the center of the deck was a spot covered with sand some 3 or 4 inches deep. In the middle of this box in a pile of sand were four metal rods with metal on top of them on which to set the pots and pans. The fuel used was pieces of wood that burned under the pans. This was what you might call a real open air stove. Of course when the fire was lit there were a lot of sparks and with the wind that was blowing, these sparks would fly everywhere. Now with two 50 gallon drums of petrol not too far away it certainly did make for interesting conversation. I told the fellows that it did not worry me at all. I said that I was just going to let my insurance company worry—there was no need for both of us to worry. I don't think this line of reasoning went too well with them though.

We were headed for Agalega which back then would have been a 'new one.' Port Victoria faded in the distance. The seas were in a very fine mood with nice little swells with a sort of clockwork rhythm to them. The boat would rock from one side to the other and then the bow would go down and then the stern. I called this the Mahe Twist or the Seychelle Swing. It was a real soothing sort of thing, at least to me it was. Not having been to sea before and not having enough sense to know that such carrying on would maybe get the sea sickness bug started, I just sat back and enjoyed it all. For about the first three or so hours we were in the open channel and not too far away from land so we

were shielded from the white caps of the open sea. When we approached the end of Mahe Island I could see all those pretty white caps on the deep sea beyond. I could see that things were going to get very interesting when we left the protection of the island and were out in the real ocean.

All this time Macan was busy cooking his rice and fish. You know, down there they let the head stay on the fish when they fry it and they fry it in some sort of oily oil which never cooks the fish to a brown color. In fact when it is completely cooked it is the same color that is was when first put in the frying pan. I noticed that Doc was keeping one eye on the fish and the other on the sparks flying here and there.

Well, there we were four land lubbers about to hit the open sea in a small boat about 50' long and about 12' across. It was basically a sailboat with a small diesel used generally for docking or when there was no wind at all. It was a good sea-worthy ship and Harvey a good captain. There were no conveniences of home on board. You slept down in the hold in swinging hammocks and there is the usual smell that exists in the hold of boats like this. The smell is a little fishy, a little diesel oil, a little kerosene and a little petrol. Then there is the smell of human beings mixed up with all these other smells, and, of course, a little black cat smell thrown in with all the others. But, you are on a DXpedition. When things are not going right and the situation is a little rough I always think of all the boys back home that are watching us and getting their rigs right, locking their front and back doors so they can safely run a good kilowatt without being bothered by the FCC walking in on them. You know the old saying, "the show must go on." A few smells here and there are of small consequence—at least that's my opinion.

We were heading for a good one—Agalega Island—and the quicker we got there the betted it suited me. I had had a sample of the thrills of being chased at Monaco, San Marino and Compione d'Italia and wanted some more of it. Of course we did some /MM work on the boat telling the fellows we were on our way. Along about this time we had arrived at the end of the island of Mahe and were now heading for the open sea. Remember I am writing this little chapter in August 1965 and the trip to Agalega was in the month of August 1959—that's six years ago, so some of the little highlights here and there may be forgotten since I don't have any of my notes with me here in 4X4 land.

I am now operating a 4X5VB at what's called a kibutz. This is one of the community farms of 4X4 land. These farms here are run like a big family. This is a small one, only about 2,000 acres and about 260 adult workers, half male and half female. Everyone eats in the big dining room. There are about 4 families in each house. These houses are built long, like a motel back home and every family has about 3 rooms to use. They have a day nursery for the little ones and also a kindergarten and then grammar school. It is a good deal, but I doubt if they would work out in the States. The people in the kibutz can leave anytime they want to. Most of the people stay here all their lives. They have the security of knowing they have a roof over their heads, clothes to wear, plenty of good food, medical services and retirement when they become too old to work. Most of the people work only 6 hours or so each day. They have a swimming pool and all sorts of sporting facilities. I have heard or read somewhere that life on collective farms in some countries is not quite so pleasant and you cannot leave when you want to. That's not so here. If you are looking for lifetime security this is the place. I understand they have been running these for a long time, so they do work.

So much for the kibutz. Let me ask you if any of you fellows have ever ridden a camel. I don't mean just to get on the back of one and let someone take your picture. No, I mean ride one for a whole day. We, Dick YA4A and I did this while we were up in Afghanistan because that was the only way to get to one of the places where we operated. To me it was not much fun—and we had to ride one back too. I see why they call one of them 'the ship of the desert.' You can get sort of sea sick with that swaying back and forth while they walk across all that sand. In the afternoon and I mean *every* afternoon about 4 pm the sand storms come up and the sand is flying for the next 2 or sometimes 3 hours. At that time you are one of the nomads you have heard about. You can hardly see beyond the nose of your camel. During these sandstorms I suppose the camels go more or less by instinct with their built-in radar systems guiding them. You should have seen Dick and I with our outfits on. We really looked like 2 shieks sitting on our camels. The radio equipment and 'putt putt' were strapped on 4 other camels. This is DXpeditioning the hard way. I think Dick and I have had it as far as this kind of DXpeditioning is concerned! But you know you are trying to put a rare prefix on the air, and this is part of the game. We really

did get to see many out of the way places in Afghanistan. Oh yes, we were in sight of UI8, UL7, and UM8. We checked up on the Kyber pass area and you know there is a neutral zone there, so we took this up with the ARRL to see what the chances were for it being a new one. Also we are looking into this Kingdom of Swat business. Now that would be a dandy wouldn't it? When you run out of countries you have to make 'em. Cokes in Afghanistan (12 oz. cans) are 50 cents each! I controlled my desire as much as possible, only one can per day. There is a chance of a return trip to YA land if the ARRL makes either of the above spots a new one. Well, there you are, now back to the trip to Agalega.

Here we were just leaving the island of Mahe behind us and entering the deep blue of the Indian Ocean and the SE Monsoon was just beginning to end. Everything had been going so smoothly and nice until we got a short distance from the shadow of the island —Bang, we were in it all of a sudden. Doc pulled in his trolling line and things were secured very quickly. You should have seen that Hi-Gain model 14 AVS swing. The salt spray was all over the place, Macan was fighting his fire under the cooking thing on the deck and needless to say those sparks were flying everywhere. Everyone was hanging on to something to keep from being blown overboard. Harvey was in his poop deck house and keeping the old tub under good control since this was nothing new to him. This tossing and pitching kept up from then on until we finally came back some 3 or so days later.

Well, finally it got time to eat—after we had been tossing and pitching all this time. Since we are rice eaters in South Carolina, I told Macan to fix me up a plate of rice and fish. I noticed that Doc was keeping his eyes glued to that oily fish on my plate. When I told Macan the rice looked too dry, Macan put more gravy (gravy being oil) on top of my rice. Well, that's when Doc decided it was time for him to count the fish over the rail. Here I was sitting down right smack on the deck eating my fish and rice dinner. Doc came back from his little run to the rail and I said "Join me, Doc, the food is FB." While saying this I picked up the fish by its head and chomped down. A little oil dripped from my hand to the deck—well there went Doc again with his fish survey. Just before he departed he said to me "How can you, Gus?" During all this Lee and Mac (AIW and UQV) were eyeing the happenings and even Mac was starting to get a little pink around the gills. Lee had everything under control pretty well though. As for me, I was hungry and enjoying a delicious fish and rice dinner. I believe the oil on the fish assists it in going down. Mineral oil for assistance is not needed if you eat Macan's fried fish, they have the self-oiling feature built in already. If you want a good picture of one of these fried fish, you take the scales off a regular fish and dip it into some cooking oil, hold it up and take a good look and you will get a rough idea of those fried fish. The WØ boys from Kansas City probably had worked up themselves a good appetite watching me eat that fish, so they sent down to the hold and came up with various cans and can openers. But for some strange reason none of them had much of an appetite. As for me, I cranked up the 'putt putt' and down to the hold and radio I went and called a CQ or two and worked probably W3CRA and W4TO. I even got a message through to the XYL—Peggy—that we were under way to Agalega.

All day long it was solid overcast so Harvey could not take a bearing. I noticed that about one foot of water had accumulated in the bottom of the boat and was swishing around my ankles while I was operating the rig. I mentioned this to Harvey and he said he guessed that the old bilge pump on his diesel was not working again. I also mentioned that the toilet was not flushing either. Things were starting to get interesting you can see. We stopped using the toilet from then on and then we used the rope system where you tie one end of the rope to the bottom of the ship's mast and the other around your waist, and you sort of hang over the side of the ship and hope no snapping sharks happen to pass by.

I asked Harvey what was the ship's position. Harvey got out his charts and maps and said by dead reckoning we would be about here—pointing his finger at a place located not too far north of Platt Island. It was pitch black outside and with all the waves and wind making lots of noise I was sure that if we sneaked up on the island during the night we could not have heard the waves washing the shore. I said "Harvey, what will we do all night?" He said that he was going to let the boat drift. I said, "Harvey, suppose we are closer to the island than your dead reckoning indicates, man, we might wash ashore." He said that this was not possible since the island was surrounded by a coral reef. You know these coral reefs are like a stone wall. It's murder if a boat ploughs on to them, even worse than wrecking ashore on a nice beach. Harvey said he didn't think we would drift to

the island during the night so we had nothing to worry about. We fired up the rig, had a number of QSO's and with wet feet from the bilge water washing up around our ankles, went to bed on the swaying hammocks in the hold. I got up a number of times and went top side and tried to peek into the darkness beyond the boat, but I couldn't see anything.

Well, we did not drift on to the coral reef. Morning came and Harvey got a good shot of the sun when it was rising out of the water, grabbed his charts, and said Platt Island was over that-away and that we would see the island in two and one-half hours. Let me tell you Harvey was exactly right. The island came in view exactly at the moment Harvey had mentioned. At first it looked like a small, flat dark thing way off in the distance. When we arrived at the island Harvey said he would have to search for the one spot where it's possible to slip through the coral reef. It seems as if every one of these islands has just one opening in their coral reefs. Harvey found the spot and by timing the ship's forward motion with the swells, glided through the small and shallow opening. Things were very nice and peaceful inside the reef. No waves and crystal clear water. You could see the bottom of the lagoon and it looked only a few feet deep. Many colors of fish could be seen swimming around. Out came the fishing poles and we selected the ones we wanted to catch. We had fish for breakfast. Some of the crew jumped overboard for a swim. They dove down and brought up some beautiful coral. I asked them how deep it was and was surprised to find that is was something like 30 feet.

Well here we were at Platt Island on our way to Agalega, with the winds and waves getting a little rougher all the time. Finally we had a meeting with everyone present. From a health viewpoint things were not too good, with the toilet not working and the bilge pump not working and a good bit of water settling in the bottom of the hold. It was finally decided that if Harvey could get the toilet in good working order and the bilge pump working, we would continue on our way to Agalega. Upon opening up the toilet we found that we needed a lead ball about one inch in diameter. Well there was no such thing on board, but there was assorted pieces of lead that were sinkers for fishing lines. You should have seen Harvey and the boys melt lead on Macan's cook stove. A lead ball was cast using the sand as a mold that was under the stove. Let me tell you, they did a darn good job with that lead ball. With a little sanding and filing the lead ball was OK, installed in the toilet and boy, we had a toilet again.

Next was the bilge pump. It was torn down and completely repacked with various bits and pieces of cloth, re-assembled and installed. It worked FB also. We spent the rest of the day installing a depth finder that the WØ boys had brought along to give to Harvey. We found that it worked very well and would even locate schools of fish.

By this time the weather had gradually become worse. Getting back through that little opening in the coral reef was real tricky because this time we were inside. We waited until it was high tide and with Harvey at the wheel knowing all the tricks, we just slipped through with only about one foot of clearance between the bottom of his boat and the reef. We were off again to Agalega. But those waves and swells were a lot higher than before and seemed to be getting worse all the time. There was lots of pitching and twisting of the ship and the seasick prone fellows were really catching it now. Well, we continued on towards Agalega Island for about half a day longer. I will admit the wind was a little higher and one or two of the Kansas City boys were getting a little sicker so we had another talk about the prospects of our getting to Agalega. It was decided (against my strong protests) that it would be best for us to turn around and go back to Mahe. Our trip to Agalega was shot. Here we were only a few hundred miles from our island, a heck of a long way from the U.S.A. and we were giving up right when a little bit more 'toughening it out' would have put us on the island. I decided then and there that from then on I would be a lone wolf on any other DXpeditions. I have found that you have to have a great deal of patience, take some risks and be a little careless if you want to get to some of the more remote spots in the world. Things just don't go smoothly, at least for me. There is always something turning up that makes thinks look impossible nearly all the time. It seems like the Indian Ocean never does get really nice and smooth.

We arrived back in Mahe and as far as I was concerned the trip was a complete failure. But I made up my mind that one of these days I was going to return and go to some island in that area and put it on the air. At least the trip, as far as we went, convinced me that I could take the rough seas and not be bothered by seasickness. Ole Gus a sailor! We operated VQ9A for a few days while QRX for the "State of Bombay" to arrive from Bombay to take us back to Mombassa.

The return trip was uneventful. We just sat on deck and watched the flying fish take off when the boat ran into a school of them. You know these flying fish can actually leave the water, take to the air and fly as far as 150 to 200 feet, getting up about 15 to 20 feet in the air. At times one would land on deck. Some seemed to be as large as 10 inches long, but usually they are about 6 inches or so. We saw a whale or two in the distance come to the surface and blow. I had no idea I would ever see a whale doing just that. Each morning we saw a number of porpoises following the ship usually in groups of three or four.

I had some long talks with one of the wireless operators on the boat. We soon started talking about things back in India. His home was Bombay and he had been living there all his life except while away on some ship as the wireless operator. The subject of what happens to those shiploads of wheat that is sent from the USA soon came up. He told me that he understood that this was supposed to be given to people who needed it to keep from starving to death. He said that he had never talked to or met anyone who had actually received any of this free wheat. He said things worked out like this: The wheat is shipped in bags of about 25 pounds each, with the usual handshake of Uncle Sam on each bag and a message saying something like "from the U.S.A." When the ship is unloaded all this wheat is taken to someone in the food business for distribution. At this distribution point the wheat is removed from these 25 pound sacks and put into bags of 2 pounds each—*just plain bags*, no hand shake or any other message is on these bags. Then they distribute them, *but not free*. They are delivered to food stores and as far as he knew they were put on their shelves and *sold* like other things on the dealers' shelves. He said if any of this wheat was ever given to anyone, he had never heard about it. He asked me why we did not do something about it. Here we were practically giving away millions of dollars worth of wheat every month or two with practically no one ever benefiting from it and that the Russians would spend about one tenth the amount we did, but that they would put up a small hospital in some village with the words 'From your friends in the USSR' engraved in stone on the front of the building. He said the people believed what they saw, and this is what they saw! They did not see all this wheat that was sent to them, or at least when they saw it they did not recognize where it came from or who

sent it. The above is the opinion of the fellow whom I talked with and not mine. Possibly it's true, possibly not. I suppose it would be interesting if all this was ever checked up on. Someone's eyes might really open if the truth were ever found out. I do know that in VU2 land a lot of manipulating and scheming takes place and it's not beyond possibility that something like this does actually happen.

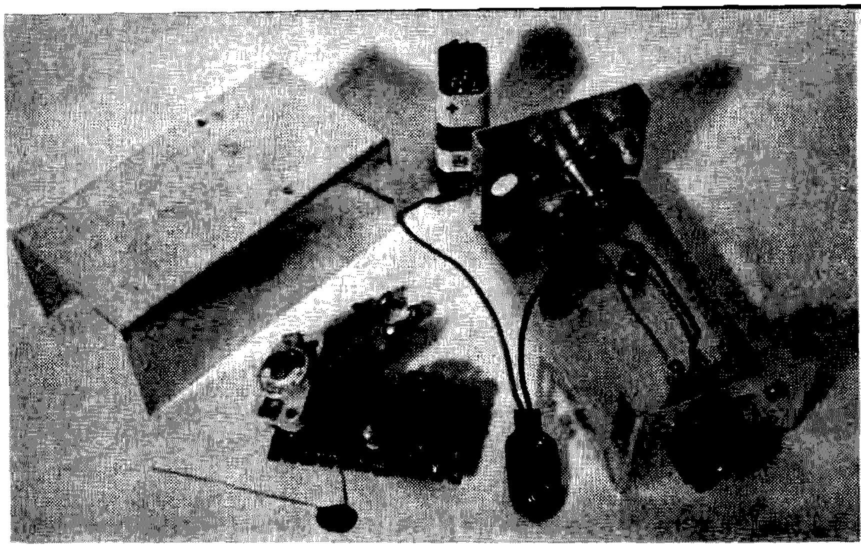
Well, we were back in Mombassa and as usual we had to spend a whole day there while QRX for the overnight train to Nairobi. Ole Doc handed me a fistful of money and asked me to go and buy a good assortment of weed carvings like I had previously bought—and at the same price I had paid. Before I left Orangeburg, South Carolina I was passing the 5 and 10 cent store and they had a big sale on genuine plastic costume jewelry. Well I decided that being a sort of hoss trader I would buy a little of this junk and take it with me, thinking possibly I could make a deal with some native somewhere along the way. I bought a big bag, spending a total of $15.00. I had completely forgotten that I had this stuff with me until I unpacked over in VQ9 land and found this bag of stuff down in the bottom of my suitcase.

I decided I was going down to have another hassle with those natives over their carvings for Doc and that this was my chance to see if it was possible to do any 'hoss tradin' with them. I removed everything from my briefcase and dumped that genuine plastic jewelry into it and away I went to market clutching my little goldmine. Upon my arrival there I proceeded to turn my pants pockets inside out, saying I have no money to spend (Doc's money was in my coat pocket) but I said that perhaps we could do a little business. I told the young man to get two pieces of everything he had and to make a pile right there on the ground and let me look it all over and to give me his very cheapest price. Well he did just this and there was a pretty good pile of carvings there on the ground. A crowd had gathered to see this big business transaction take place. Well he gave me his price, and I gave him mine. He came down and I came up a little, we haggled and we haggled. Our prices were still a good bit apart so I said I would have to go around the corner and buy from the Indian shop. I walked away about 100 feet when he called me back. We argued and argued some more. Finally he froze and so did I. I said that I was sorry we couldn't do business and that I was going back to my hotel for lunch. I shook hands with him and departed. I actually got into the lobby of the hotel—and there came a fellow running and said that I should come back, that they would sell at my price! I went back and he got three big boxes and carefully wrapped everything. When the boxes were all ready I said to him, "You are a good fellow and I want to do something for you. I opened up my briefcase and slowly pulled out a long plastic necklace and held it up. You should have heard the native YLs! I passed it around to the crowd and eventually put it back in my briefcase. I told the young man I would give him all the genuine plastic jewelry for another stack of carvings. He said he could not give me two of everything but just one of each item. I said no, no, no. I proceeded to explain to him that this was genuine plastic and not the cheap imitation that you could find anywhere at cheap prices.

After more yakking and haggling he said he would do this for me. I started to hand him the money and the jewelry and I said, "Wait a minute, we can't do business." (I had seen a BIG elephant carving under the table—he had only one of these and it was about 3 times as large as anything he had.) I pointed to this and said that if he would throw this in as backsheesh we could close the deal. I said that this was my final offer and that he could take it or leave it. After talking with his father, who had been standing on the sidelines during all this, he agreed and away we went to the hotel with 6 boxes of carvings. Good Ole Doc was completely satisfied and, to tell the truth, so was I.

In a few hours we were on our way to Nairobi on the train, out through lion country. Upon arriving there I stayed with George VQ4AQ this time. I found that, at last, my equipment had arrived from Milan. Why it took a month to get there I never did find out. While attending to things, the Kansas City boys made a quick trip down to VQ1 land (Zanzibar) just as tourists. When they arrived back I had everything done and I took off for VQ1 the hard way, via African Bus through the jungle to Dar-es-Salaam. Now this was some trip. *You* ride an African Bus from Nairobi to Dar-es-Salaam and you will see what I mean. Monkeys, snakes, lions, elephants, zebras, gazelles, vultures, you name it, I saw it by the hundreds. It is a two-day trip, and rugged to say the least.

Next month I will tell you about meeting VQ3PBD, good old Peter Dobs, and about operating in VQ1 land when it was a rare spot. I am still seeing the world and enjoying every minute of it too. This is country number 99 for me! I wonder if I will ever get to number 100—DXCC. Maybe I will, maybe I won't—who knows? . . . GUS



John Crawford WA4SAM
George Webber W1DVG
40 Morris Street
West Lynn, Mass.

Build the OTC

A one transistor converter for 28-54 or 108-176 mc

The following converter is your answer to a sensitive and inexpensive receiver for your car. When used with the usual car broadcast radio it will provide excellent monitoring of the two, six, and ten meter bands as well as police and fire frequencies on the low and high bands. Total cost is about three dollars with a well stocked parts box, or a kit can be obtained by writing Webber Labs, 40 Morris Street, West Lynn, Mass. If you choose to build your own you will need a crystal and a special high frequency transistor available as surplus from the above address for a total cost of $4.00.

Two different versions are shown, tuning 28-54 mc and 100-200 mc respectively, the only difference being in Coil L1. If desired, plug-in coils may be used but due to the low cost of the parts it is easier to build two converters.

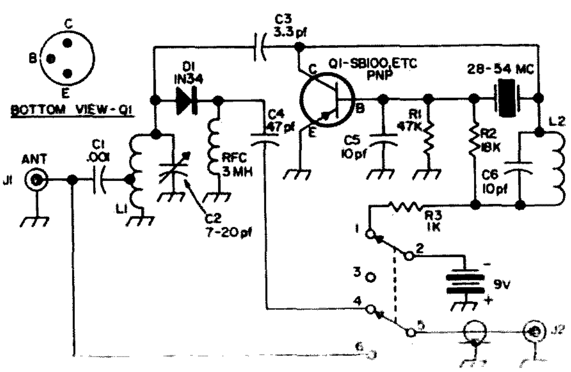


Fig. 1. The OTC. L1 for 100-200 mc is 4 T #16 wire, 1/4" diameter, tap at 1 T from ground. For 30-50 mc L1 is 36 T #30 on 1/4" dia form 1/2" long, tap 11 T from ground. L2 is 36 T #30 on 1/4" diameter form 1/2" long.

The unit is housed in a small 2"W x 4"L x 1⅝"D Minibox. Parts are mounted by their leads on a 1" x 2" piece of perf board and proper connections made on the underside of the board with the extra lengths of component lead. Because of the high frequencies involved wiring should be kept short and as much point to point as possible. Placement of parts is straight-forward and should cause no trouble if the pictorial is followed. Be sure to leave room at each corner of the board for the mounting holes.

When winding coils L1 and L2 use the specifications shown in the parts list. Because of the small size of the coils it may be easier to solder one end of the wire to a lead on the coil form and then turn the form between your fingers, feeding the wire as you turn. After every few turns or so, apply a small bit of candle wax to the completed part and heat the coil slightly to melt the wax in. This will prevent the wire from slipping off the form. When making the tap on L1 in the 28-54 mc model, be sure to continue the winding in the same direction as before.

Next, drill or punch holes in each end of the minibox and mount the antenna jacks, switch and crystal socket as shown. Drill holes in each corner of the perf board and mount it in the bottom of the box with small grommets or spacers to prevent the leads from shorting against the chassis. Finally, make the connections from the board to the mounted components on the box as shown in the pictorial.

In the authors' model a nine volt battery was used for power and taped to the outside of the OTC. Because of the small amount of

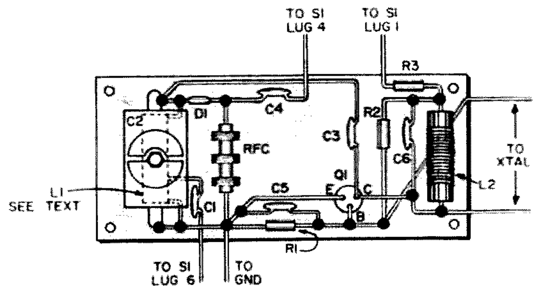


Fig. 2. Layout of the OTC. The converter is built on a 1" x 2" piece of perforated board.

power required by the circuit, the battery will last most of its shelf life. Power may be tapped from the car battery and R3 changed but this will result in more noise through the engine's electrical system.

With a crystal plugged into the socket the converter is ready to go. To determine crystal frequency, use the following formulas:

For the 28-54 mc converter

$F_1 - 1.2 = f_c$

For the 100-200 mc converter

$\frac{1}{3}(F_1 - 1.2) = f_c$

F_1 is the frequency you wish to tune in megacycles

f_c is the oscillator frequency in megacycles. The answer to the above formulas is the frequency of the crystal in megacycles. When ordering from Webber labs it is not necessary to figure the frequency but be sure to specify the frequency of the station you wish to monitor.

Plus in a jumper lead made of about twelve inches of coaxial cable with a male Motorola plug on each end into J2. Plug the other end into the radio and the antenna into J1. With S1 set in the off position turn the radio on and tune the dial. The usual commercial stations will be heard. If not, check the wiring of S1 and the antenna circuits. If all is okay, push S1 to the on position and tune the radio to 1200. A slight hiss will be heard and if the crystal frequency is correct you should hear a signal when the station for which you are listening transmits. It may be necessary to adjust C2 slightly to obtain maximum strength. By tuning the dial a wide range of frequencies may be heard. However, for stations which are far apart in frequency, different crystals will have to be used. The farther away from the crystal frequency the lower the sensitivity.

The OTC may be mounted permanently under the dash or placed in the glove compartment of the car. It's about the easiest way to get good reception of these interesting frequencies for mobile use.

. . . WA4SAM, W1DVG

The EICO 753K

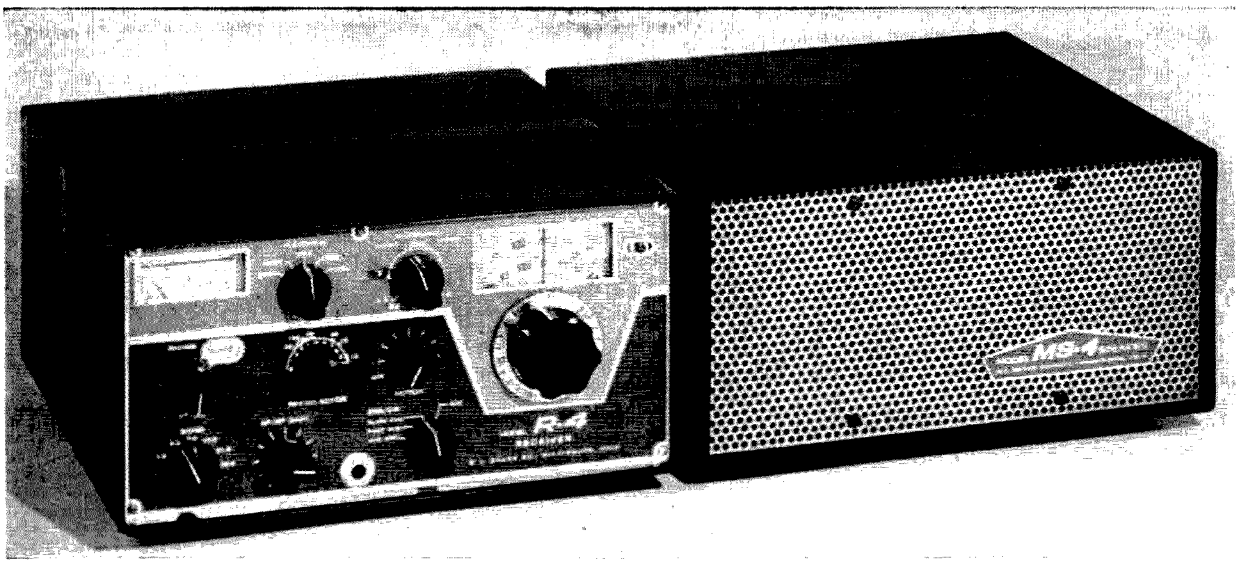
Melvin Leibowitz W3KET
Charles Pappas W3TND
Wilmington, Delaware

The authors recently completed an EICO 753, tri band SSB-AM-CW transceiver kit. The kit sells for $179.95 and in our opinion it is worth every penny. Power input is 200 watts PEP on SSB and CW and 100 watts on AM. Full frequency coverage of the 80, 40 and 20 meter bands is provided. The receiver section has an offset tuning control so that it can be detuned a few kilocycles from the transmitted signal in case the other fellow drifts or is not exactly on frequency. This control is smooth and easy to operate as is the entire transceiver. The transceiver is housed in a heavy gauge perforated steel cabinet with a cast aluminum front panel. Machined aluminum knobs are used and the "feel" is excellent. The main tuning dial is a dual ratio with ratios of 6 to 1 and 30 to 1. This allows rapid band coverage and at the same time gives a good tuning rate for sideband. The receiver is very sensitive on all bands and although we did not measure the rf output; our dummy load light bulb was very bright indicating good efficiency in the transmitter. The set has an effective ALC system on transmit as well as good AVC action on receive.

Construction of the kit was not difficult. The crystal filter is factory assembled. The VFO and if strips are built on printed circuit boards and go together quickly and easily. The audio, VOX, and final rf Section are of conventional construction. All parts are readily accessible and the wiring is "single layer". Alignment was easy and did not require test equipment. The if alignment is accomplished by using the carrier oscillator as a signal generator and the receiver "S" meter as a vacuum tube voltmeter. All other stages are aligned by peaking the tuned circuits for maximum output when transmitting. There were some minor mistakes in the construction manual which is not too surprising for the first run of a kit as sophisticated as this one. They did not cause us any great trouble and conversation with EICO indicates that later manuals will be corrected.

Twenty minutes after the last connection had been soldered in place, we had the unit aligned and on the air. Reports were very flattering in regards to suppression, voice quality and frequency stability. We were impressed by the receiver stability and the general ease of operation and in conclusion we hope that EICO will continue to expand their ham line with other modern, high quality kits such as this one.

. . . W3KET, W3TND



William Johnson WA2TDR

The Drake R-4 Receiver

Recently I became the owner of a Drake model R-4 receiver. After using it for several months I was impressed enough by its performance to write this review for the benefit of others who may be contemplating the purchase of a new receiver.

The model R-4 receiver is capable of receiving in the SSB, CW, AM and RTTY modes of operation. Its frequency coverage is 3.5 to 4.0 mc, 7.0 to 7.5 mc, 14.0 to 14.5 mc, 21.0 to 21.5 mc, and 28.5 to 29.0 mc, with the crystals supplied. Ten accessory crystal sockets are provided for the coverage of any additional 500 kc ranges between 1.5 and 30 mc with the exception of the 5.0 to 6.0 mc segment. This is one feature that I particularly like as the receiver can never become obsolete if any of the ham band frequencies are shifted. In addition it covers the 160 meter band by using one of the ten accessory crystal positions, or for the VHF enthusiast the accessory crystal selector can be used to provide 5 mc, of continuous coverage for use with VHF converters. Too many equipment manufacturers are omitting the 160 meter band where the Drake Company recognized that the band still belongs to the radio amateurs.

The first if frequency of the R-4 is 5645 kc. The receiver uses a crystal lattice filter at this frequency giving excellent cross modulation and overload characteristics by providing selectivity before the gain producing stages. A tunable passband filter with selectivity switching is used to achieve additional selectivity at the 50 kc intermediate frequency. Four degrees of selectivity are available, without having to purchase additional filters. The passband at the 6 db point on the switchable filters are 0.4 kc for CW, 1.2 for RTTY, 2.4 kc for SSB, and 4.8 kc for AM.

Excellent frequency stability is assured by the use of a permeability tuned oscillator. The specification calls for less than 100 cycles drift after initial warm up. I have found that the stability is in accordance with their specification. The oscillator covers 4955 kc to 5455 kc and is premixed with a switchable crystal controlled oscillator. The output of the premixer is 5645 kc above the frequency of the desired incoming signal. A bandpass coupling transformer between the premixer and the first high frequency mixer attenuates the undesired mixer products.

When the mode switch is in the "SSB/CW" position the output of the 50 kc if amplifier is connected to the input of the product detector. When the mode switch is in the "AM" position the 50 kc local oscillator is disabled and the if signal is detected with a diode, providing AM detection without having to result to zero beating the carrier as required by SSB receivers lacking the additional AM detection system.

The main dial is calibrated in 5 kilocycles divisions and has two scales. The 0 to .500 scale is used for bands 7.000–7.500, 14,000–14.500, 21.000–21.500 etc. and the .500 to 1.000 scale is used for bands 1.500–2.000, 3.500–4.000, 28.500–29.000 etc.

The vernier dial skirt is calibrated in one kilocycle divisions. The scale on the vernier dial is marked 0 to 25. The dial skirt is adjustable by pushing it in slightly and rotating

it in the desired direction while holding the main tuning knob stationary. After adjusting the dial skirt the 1 kc divisions track across the main dial so that 5 kc on the vernier dial skirt coincides with the 5 kc divisions on the main dial. When the vernier dial skirt is calibrated using the built in 100 kc crystal calibrator the calibration accuracy is better than 1 kc when the main dial is calibrated at the nearest 100 kc point. The tuning dial turns easily without any backlash. The ease of tuning will be appreciated by the VHF operator that tunes across the complete dial when tuning crystal controlled converters.

The specification lists both the image rejection, and the if rejection in the ham bands as more than 60 db. The internal spurious responses in the ham ranges is less than the equivalent of 1 μv signal on the antenna. I have not found any spurious responses, and have not experienced any image frequency stations in this area appearing in the ham bands.

The specification claims less than 0.5 microvolts for 10 db signal plus noise to noise ratio on all ham bands. I have not measured the sensitivity, but after comparing it with other receivers on the market claiming similar sensitivity it competes with the best money can buy.

Other features contained in the R-4 are: the noise blanker which can be used on CW, and SSB, as well as AM. The permeability tuned "T" notch filter in the 50 kc if strip. This filter is capable of producing a deep notch which can be tuned across the if eliminating interferring carriers in all modes of operation. The automatic volume control has three positions, ie, off, slow, and fast. The receiver has provisions for muting the rf stage off during transmit. The premixed vfo output is brought to a connector so that the receiver can transceive with the T4X transmitter.

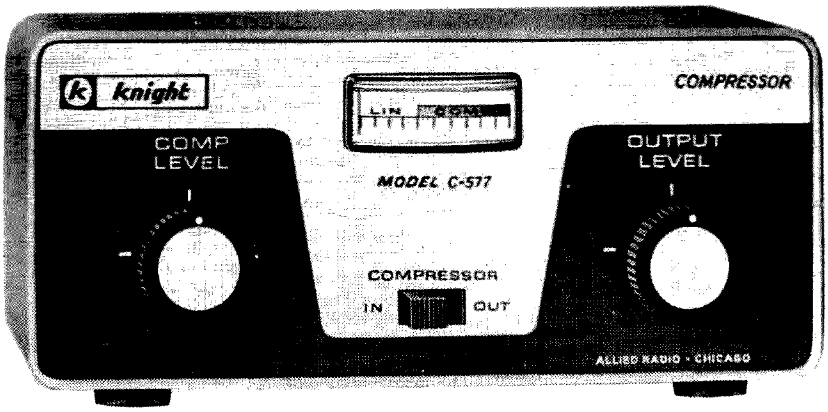
Using the receiver in my two favorite modes of operation, SSB and CW, the R-4 satisfied all my expectations. The features and construction are of the same caliber as the TR3 transceiver and the 2B receiver that earned Drake their present reputation as a manufacturer of amateur products.

The overall dimensions are 5½" high, 10¾" wide, and 12¼" deep.

Incidentally, the new R-4A is identical except for minor production changes including a solid state VFO.

The receiver price is $379.95 with the matching speaker available at $19.95.

. . . WA2TDR



73 Tests the Knight Kit C-577 Compressor

Hams have long known the advantages of compression in the modulation of a transmitter. You can look back at old handbooks and see the very complex and cumbersome equipment that used to be necessary to add compression to a transmitter. Then you can look at the neat, compact Knight C-577 and see how far we've come. This simple, easy-to-build compressor/preamplifier connects between your microphone and transmitter mike input in a few minutes. Then it can be switched in and out of the circuit with adjustable compression and output to provide you with maximum audio for any situation.

The C-577 comes as a kit. The "job" of building it takes about an hour even for butterfingers. Almost all of the parts are on a sturdy printed circuit board and the C-577 uses three modern silicon transistors for reliable operation. The circuit board mounts easily with the controls and common 9 v battery in the attractive 2⅞ x 6⅝ x 3" sea blue and silver case. Then it's ready to connect to your transmitter with the double shielded cables that are provided in the kit for use with push to talk switching.

Once the C-577 is connected up, you find that it offers preamplification for low level mikes—up to 26 db at 1 kc. Compression can start as low as 2 mv with full compression limiting output to 50 mv as desired. The input and output impedances are more than 50,000 ohms and frequency response is within two decibels from 300 to 5000 cps. Because of the transistorized-battery operation, hum and noise are more than 50 db down from the maximum output.

The compressor boosts the output of your modulator when you mumble, then limits it when you talk too loudly to give a high average level of modulation. You can easily adjust the unit so that your transmitter will not overmodulate no matter how hard you shout! The big advantage of a compressor such as this over the more common speech clippers is that it introduces very little distortion. All broadcast stations use compressors; I'm sure none use clippers. Of course, hams don't want high fidelity in frequency response, but we do want low harmonic and intermodulation distortion so that our signals are clean and pleasant to listen to. Clippers are notorious for harmonic distortion—that's why they have to be followed by filters. The distortion that a compressor introduces is mostly a matter of phase and amplitude, which is not unpleasant.

I connected the C-577 to a 50 watt 6 meter AM transmitter, got into a contact with a ham just about on the limits of my modulation, and tried the switch test. He said that it made quite a difference. Without the compressor, my voice was weak and partially unreadable. With the compressor in the circuit, it was much stronger and R5 copy. Even with deep compression, the sound wasn't too bad. In fact, my voice is pretty bad without the compression. At any rate, you can always reduce the compression a bit if there are any complaints. The attractive edgewise meter tells you how loudly to talk.

At $19.95, the Knight C-577 is an excellent buy. You'll never know the difference a compressor can make until you try one.

. . . WA1CCH

Kenneth Robbins W1KNI
Sperry Rand Research Center
Sudbury, Massachusetts

VFO Stability: Part II

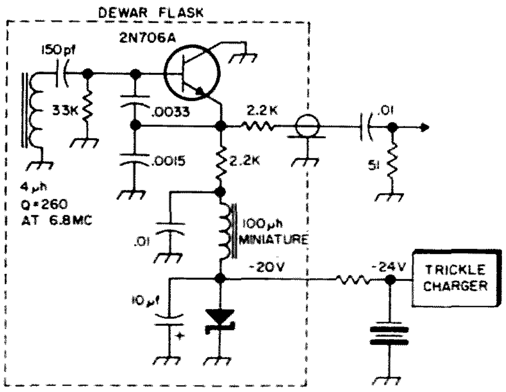
The article by W6BUV on VFO stability[1] is excellent reading for anyone thinking about exploring this area of ham activity. Having been active in the RF oscillator field for almost 20 years, I wish to add a hearty "Amen." Personal experience with vacuum tube oscillators gives the nod to the Clapp using a Telefunken 6AU6 or the Robberson[2] running at +12v dc on plates and heaters of a 12AU7 (Telefunken) and 12EC8 untuned buffer/cathode follower. Each will hold frequency close to $1x10^{-5}$ with careful construction. With ambient temperature variation held to $\pm 1°C$, regulated supply voltages and fixed load they improve by almost an order of magnitude.

However, transistor oscillators CAN do even better by eliminating cathode interface impedance, microphonics, element heating, power supply problems, etc. Solid state devices are not a cure-all and they do raise questions of junction heating and capacitance effects along with low frequency "burble" (random FM), to name a few. These varied ills are greatly reduced in the Lee[3] oscillator which is one of the best to come along so far. Some lunch-hour and after-five tests were run on this circuit in the lab to determine its possibilities as a transmitter VFO. Its best performance was a stability of $3x10^{-8}$ for about 2 minutes with a long term drift of 280 cps in 8 days. Of course this extreme stability of an LC oscillator required precautions and these are outlined as follows.

A single 2N706A silicon transistor was finally chosen along with a high Q ferrite toroid coil form, dipped silver-mica capacitors in the tuned circuit and deposited carbon resistors. This fixed-tuned oscillator, running at 6.8+ mc, was assembled on a 5x7 cm phenolic board together with a 20 volt zener diode to regulate B+. The assembly was secured to the bottom of a straight sided 667 ml Dewar flask. Fibrous insulating material filled the space between the unit and the open end of the flask. A ½" thick aluminum disc, well fitted to the flask sides, acted as a closure. A heating device in intimate contact with the disc maintained its temperature at 40°C±1°. Microdot coax brought out the RF signal and B+ on a #30 wire came through a dropping resistor from a 24v DC nickel-cadmium battery supply, constantly trickle-charged. A 2.2 k isolating resistor in the oscillator minimized any "outside world" effects on its 50 ohm fixed load. The signal was applied to a HP 524 frequency counter and printer, the counter being driven by an external standard having better than $1x10^{-10}$/day drift. And all this in an air-conditioned lab!

The oscillator was run continuously for one week before meaningful measurements were made. Its best run after this break-in period was a downward drift from 6,889,747.9 cps to 6,889,747.7 cps in 130 seconds. From this and many other earlier experiments useful data has been obtained and is passed on to 73 readers who wish to try their hand on LC transistor oscillators.

Use a well-proven silicon transistor having low capacities, moderate beta, voltage and power dissipation ratings and good high frequency characteristics. The mesa type con-



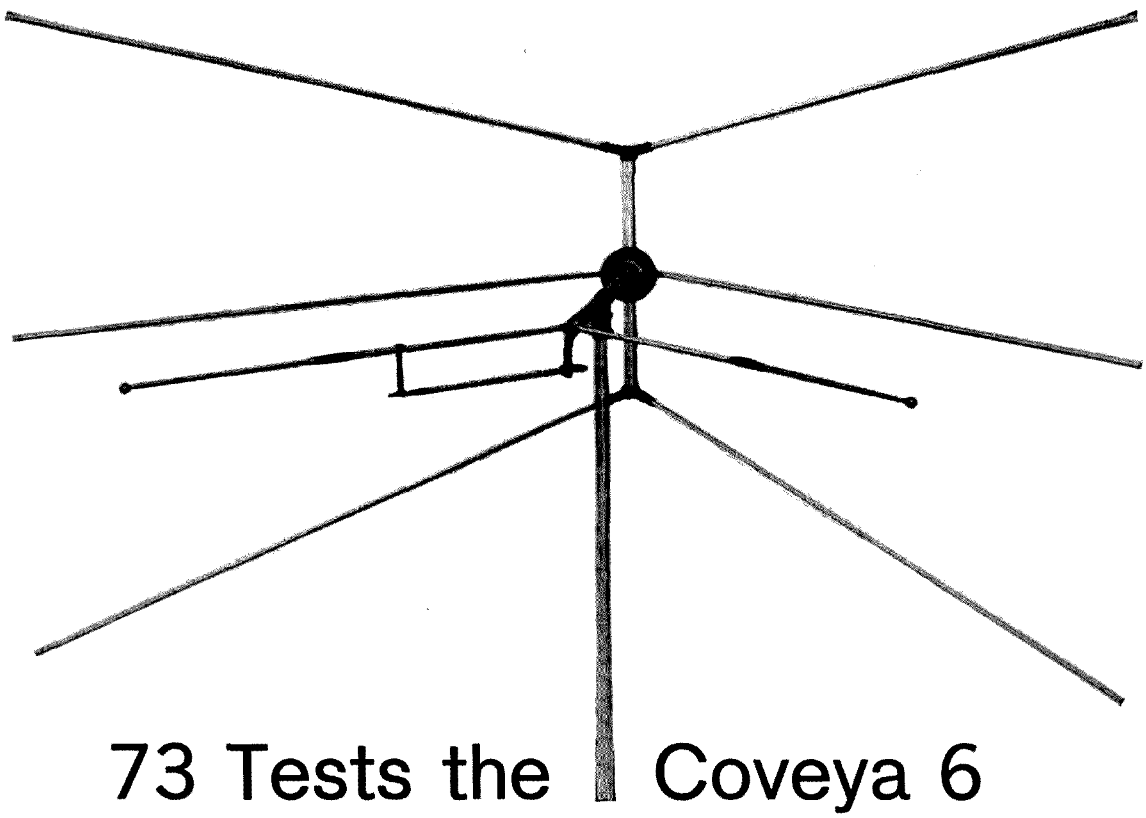
ig. 1. Suggested circuit for a solid state oscillator.

truction in the 2N706A fills these requirenents well. Use high collector voltage and low urrent to reduce collector-base capacitance vith little junction heating. Solid state deices and iron-cored inductors in the oscillator ircuit must be temperature stabilized. The nductor must be high Q, at least 200. A coil poxy-bonded to a ferrite toroid works quite vell by confining the magnetic field which reluces coupling effects to adjacent structures. /oltage regulation and/or base bias adjustment vill minimize effects of B+ variations on frequency. Reactive feedback from following tages can be held down by an isolating reistor of as high a value as possible. Small apacitance output coupling does not work as vell. Use only passive element phase shifting. Bypass all zeners with electrolytics to reduce noise, especially at audio frequencies. Tap down as far as possible on the tank circuit to obtain good impedance matching. The Lee circuit is excellent because a very large capactance swamps the high capacity of the forvard biased base-emitter diode which is a najor source of 'burble'. In this oscillator a value of .0033 µf is used at 6.8 mc, a reactance of 5.5 ohms. And don't forget to keep Bill Goldsworthy's construction points in mind!

Lest these high-powered lab techniques scare some hopefuls away, I hasten to add hat a much less exotic oscillator was contructed at home, operating near 5 mc. Its 10th harmonic at 50 mc was used for carrier reinertion on SSB signals in the 6 meter band, enabling reception in the regular AM mode. A few were found with incidental FM, not usually detected with the receiver in its sideband mode. This is stability of about $5x10^{-7}$, comparable to quartz oscillators.

. . . W1KNI

(1) "VFO Stability," *73*, September 1965.
(2) "RF Oscillator has Improved Stability," *Electronics*, August 1963.
(3) "Synthetic Rock," Commander Lee, *CQ*, September 1963.



73 Tests the Coveya 6

When a ham sees a Coveya 6, he says, "It looks like a TV antenna."

When a neighbor sees the Coveya 6, he doesn't say anything. It doesn't look like a ham antenna at all to him.

To some hams, the fact that the Newtronics Coveya 6 looks like a TV antenna is unimportant-or even slightly funny. But to those of us who live in areas of bad TV reception, it can be a blessing. As all hams know, antennas cause TVI—not transmitters. No one with a bum TV set accuses his neighbor of causing trouble unless he knows that the neighbor is a ham—or has up a ham antenna.

But it would be ridiculous to think that this is the only advantage of the Coveya. In the first place, it's very compact. The special design makes it narrower than yagis and other antennas. The boom is only 34" long. The Coveya 6 is amazingly strong. It's made of seamless heat treated aluminum tubing. The brackets are solid iridite finished aluminum castings; no cheap stamped parts here. The ends of the elements have aluminum rod plugs for extra strength and to keep out water. It's very light, too.

Electrical specs that Newtronics publishes are 10 db gain over a half wave dipole and a front-to-back ratio of 25 db. The Coveya is gamma matched to 52 ohms and very easy to adjust. The SWR when properly matched is about 1.1 to 1 at resonance, and under 2 to 1 for a megacycle. You can set the center frequency anywhere from 50 to 54 mc, though I set it at 50.2 for SSB. The antenna will handle a KW; I used it with about 150 watts PEP.

The Coveya is a real pleasure to use in round tables. You won't have to keep twisting the rotator knob for each station. The beam gives a cardioid pattern with no side nulls. I live in a very poor spot for hamming, in a valley with a large hill about 50 feet from the antenna between me and Boston. Then there's a mountain behind that. I almost didn't bother going on the air, but decided I'd try the Coveya. I jerry-rigged it about 10 feet above the roof on a one story part of the house pointed right into that hill. Needless to say, I didn't expect very good results. But I had no trouble working into Boston 70 miles way where the beam was pointed and into Connecticut a little off the side. I didn't bother with the rotator since I had little hope, but could hear all sorts of stations around the front of the beam. One of the hams I worked in the Boston area said that he'd never heard of anyone down in Peterborough (as opposed to on the mountain, Pack Monadnock) getting out on six. Looks like the Coveya 6 and SSB make the difference. Maybe I'll get around to putting up that tower with the Coveya on it yet.

. . . WA1CCH

Hank Cross W1OOP

Experimenting with Varactors

If all you want to do is get some output on 432 mc the procedure is simple: buy an MA-4062 and build a tripler to multiply your 144 mc transmitter output.

If the object is to play with or demonstrate the use of variable-reactance diodes in frequency multipliers or other applications, there are cheaper diodes that will do the job very well, at frequencies from one to thirty megacycles.

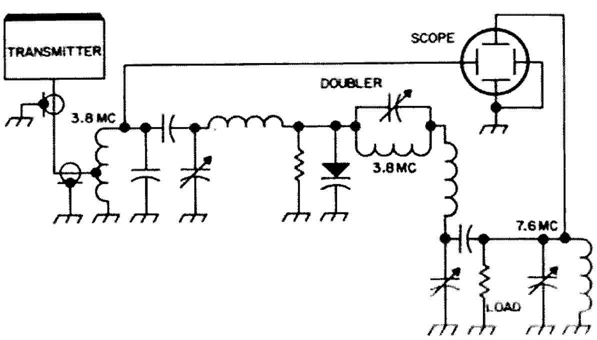
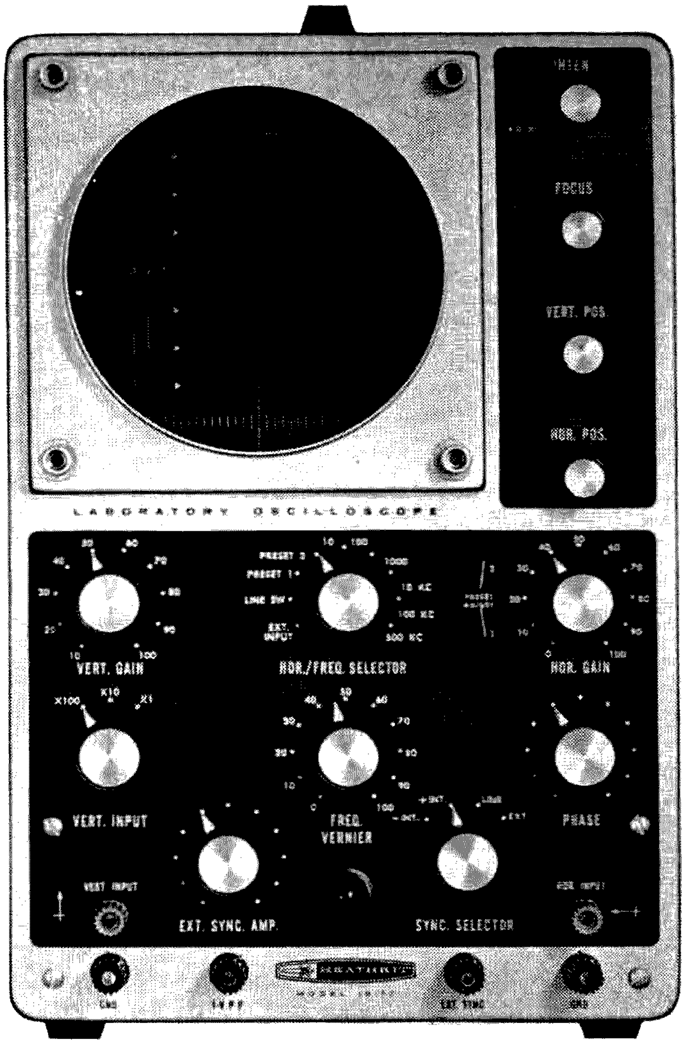


Fig. 1. Experimenting with varactors. This circuit uses a common silicon power diode to double from 80 m to 40 m.

Hughes, PSI, and other companies make variable-capacitance junction diodes which have Q's of ten to several thousand at one megacycle: PSI makes diodes suitable for use up to several thousand megacycles at fairly high prices, but the V-100 varicap will perform very well in the range below 10 mc, at moderate cost. Another source of low-frequency "varactors" is common silicon power diodes. I have seen experimental circuits working at ten to thirty megacycles using GE 1N1199 and 1N2154 series power diodes, with good efficiency.

Although I have not tried it, it seems that it would be fairly easy to make doublers and triplers from 3.8 megacycles using power diodes and a novice transmitter for a source. To establish that operation is on the proper frequency, output from the transmitter, idler tanks and output tanks can be put on to the deflection plates of any cr scope. No amplifiers need be used; the rf across the tanks should be several hundred volts, and by putting the input tank voltage to the horizontal plates and the output to the vertical deflection plates a lissajous pattern will be obtained that will tell the frequency ratio directly.

. . . W1OOP



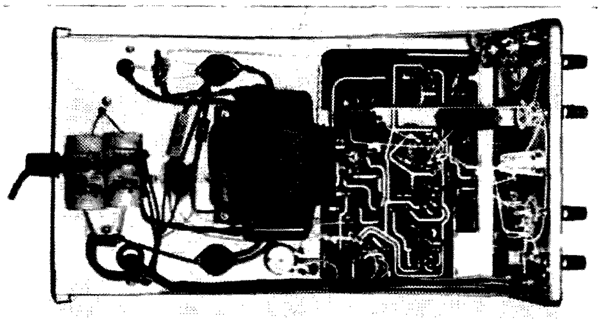
Ken Cole W7IDF
P.O. Box 3
Vashon, Wash.

Twelve Centimeter Heathscope

The Heath Model 10-12 five inch scope is particularly easy to assemble and wire. Accessibility for testing and repair would please the most hot-tempered servicemen. Two circuit boards are used, and should it ever be necessary either of these can be purchased as individual kits which include the sockets and components mounted on the boards.

Two pre-set sweep frequencies (adjustable from the front panel) are provided—vertical and horizontal TV sweeps were what Heath had in mind, but the two frequencies can be set anywhere within the range of the internal sweep generator. An additional feature allows the operator the choice of having the sweep start on either the positive or negative slope of the input signal. Good frequency response for a wide range of input voltages is achieved by a simple compensation adjustment of individual attenuators, after the scope is completed and operating. For measurement of peak-to-peak values a binding post provides a calibrating voltage, and although the source is a simple, unregulated divider network across the filament supply stability is satisfactory.

No problems arose in assembly or wiring, with one minor exception. When I turned the scope on the beam was well off the screen vertically and the trouble turned out to be an open peaking coil. The break was right at the terminal and required only a touch of solder. It might have been caused by excessive tension during the winding process, but more likely it was the result of my own impatient handling. The kits I've put together would fill a Microbus but I can't resist the temptation to accelerate from a crawl to a full gallop at the finish line. When I squeeze those last eight leads through the last solder lug and add a final ounce of 60-40 the feeling of relief and the happy reunion with my family make it all worthwhile. I remember the anticipation that



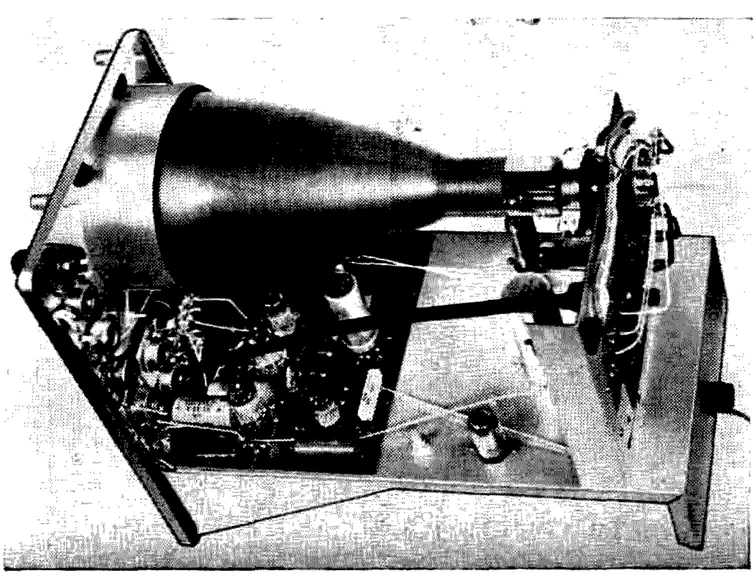
This bottom view of the Heath 10-12 shows you very little. But that's the way I like them; uncluttered and clean.

accompanies the unpacking of a new kit, forget the Solder-No Solder, strip and measure tedium, salute the geniuses who design for Everyman and enjoy my new equipment.

Maybe I've been lucky, but I can't recall a kit that through faulty engineering or overrated components turned out less than satisfactory. Not long ago I was so impressed by the performance of a relatively inexpensive FM receiver that I wrote one of those "unsolicited testimonial" letters to Heath, explaining in some detail why I was pleased with their product—and adding in some detail why I thought they should divert more of their advertising budget to 73. I didn't expect a reply and I forgot about the letter. Some time later I received a wire from Benton Harbor. Mr. Earl Broihier quoted my letter and requested that, if I would allow my remarks to be used in an advertising campaign, I reply using a release form included in the Heath telegram. This I was happy to do, of course, and I even refrained from including in my collect wire more advice about the advantages of large monthly displays in a New Hampshire technical journal. The magazine touting aside, and I harbor no illusions that it made any impression, I think my goodwill was thereby established and perhaps no personal pique will be construed from the following qualified recommendation of an optional accessory to the 10-12 scope.

The EF-2 Educational kit costs $9.95. If purchased with the $76.95 five inch scope the combination price is $84.95. The book supplied, "How to Understand and Use Your Oscilloscope," is worth the price of the kit, and you may find the chassis as useful as it is intended to be. The circuits designed to illustrate the applications of the scope all worked fine, but my feeling was that the unique, convenient approach to solderless assembly was more unique than convenient. For this kind of work the vertical plug-in spring connectors seem to me to be handier, and the parts you attach to them needn't be modified first. The EF-2 board requires that components be soldered to tiny spring clips before they can be used. I may be a minority of one here. See what you think. In any event a generous supply of parts and three transistors are included with the chassis and I'm glad I paid an extra eight bucks to get the EF-2. The book is first class. Finally, there is another text you will find worth having if you are really curious about scopery in detail. This one is *Oscilloscope Circuit Applications*—volume five of an eight volume electronics series set up for the Bureau of Naval Personnel. The Superintendent of Documents, Government Printing Office, Washington, D. C., wants a dollar and a half for this bargain and telling him you saw it in 73 won't make any difference.* . . . W7IDF

*Never Say Die. *Ed.*



The Heath 10-12 is very easy to wire. You can see that almost all the parts are on the circuit boards. It's easy to use, too.

Letters

Dear Wayne:

Your November editorial comment about the code requirement for amateur licensing has certainly hit the nail on the head. I have felt as you do about the code requirement ever since I received my ham license in 1947 and have argued many times with other hams regarding the code requirement.

There is unquestionably much to be gained by stiffening up on the technical written exam for amateurs. A good example of what can be done occurs in another field—the field of general aviation. Prospective instrument pilots are given a written exam which is intended to—and believe me it does—separate the men from the boys. The stringent requirements for instrument pilot make it possible these days for instrument rated pilots to operate on the airways under instrument conditions and not get in the way of all the commercial traffic.

If the amateur written exam were stiffened up, it would stop once and for all the current cry heard in some quarters that "amateurs don't know anything about radio these days."

J. A. Smith Jr.
Newburgh, New York

Dear Wayne:

The best thing that happened to me this year was meeting you at the SSB Dinner at the Waldorf Hotel in London in May. I had a quick look through the 73 Mag you gave me and if you remember immediately gave you the cash for a years subscription. I read the mag from cover to cover. I like your honest, straight-to-the-point editorials and the articles and comments are right on the ball. For me 73 is Top of the Pops. I would like to correspond with any readers using a SBE 33 Transceiver.

Continued success to you and 73 Mag and I hope it will not be too long before we have another eyeball QSO, also another 20m QSO. If you are ever in 'G' land drop in on me.

Roy Reynolds G31DW
Wiltshire, England

Sir:

You speak of bad manners on the air, well you haven't heard anything. I am a Negro and have had a license for seven years. I have a reasonable I.Q. and like to think I am fairly intelligent. I have never attempted to "talk white". I very often hear snide remarks, and sometimes a ham I am in QSO with will lapse into his brand of "Negro dialect". I have heard them throw carriers deliberately on top of mine. I hear hams declaring themselves on issues which have no business in ham radio. I have heard hams using derogatory phonetics, and telling "race jokes". It may be surprising to you that only a small amount of these hams are Southerners. I will continue to ham because I love it. I have met some fine fellows, whose friendships I would not sell or trade. For every crumb in amateur radio there are hundreds of fine fellows. So when you speak of manners, think of me.

Columbus, Ohio

Dear Wayne,

First of all I would like to say that I like 73 magazine. I like the articles, the editorials, and also I like the way you fight for that which you think is right.

I have been licensed since 1936, still holding my original call. I am only a General Class license holder and have no desire to obtain one of the proposed new class of license if the F.C.C. puts the new classes of license in effect. My reason is that I don't believe the proposed rules changes will improve the present condition of the particular bands involved. Any present operator who was licensed prior to WW2 will remember the condition of the 75 and 20 meter bands. They sounded lousy then. Remember we had restricted licenses then? Class A and Class B. Class A permitted operation on all bands. Class B permitted operation on all but 75 and 20 meter phone. Now as I remember it I don't think that the Class A operators were A number one operators and electronic geniuses any-more than the Class B operators were supposed to be lids and dumb-bells. Now forcing a person to take an examination to receive an advanced license to keep that which he already has will not make an operator a better operator, a constructor of equipment, or a technician. Think of all the grown up persons now, who when they were little children their loving mothers forced music lessons on them. How many today are great and accomplished musicians?

You can't force a man to build equipment. This desire has to be born in you. How many persons owning boats build them? In spite of what some operators claim to the contrary, I was always taught by the old timers before me that amateur radio was a hobby and I still like to think of it as such. There are quite a few business and professional men and women who are amateurs and they just don't have time to construct equipment even if some of them would like to. Those of us who do like to build have a hard time of it, let me explain. You can't buy parts, at least not in the Philadelphia area. Even the one surplus house does not have much to offer to the ham. I like to build and have always done so. My receiver is home brewed along with a two meter convertor. I have an ARC 3 transmitter that I am modifying for two meters using W4WKM's article in the June 1963 issue 73 magazine. Now here is something that would discourage many a ham who would like to build. Some time ago I started to build the SSB exciter described by George Bigler W6TEU in the June 1958 issue QST. I have the exciter finished and started the R.F. portion. I need a Centralab P-272 index assembly and three type GGD switch sections, also a P-121 index assembly and one type R and one type RR switch sections. I tried several parts houses. None of them had these parts in stock, only one of them would even order them for me. These parts have been ordered since Good Friday of this year, now here it is six months later and he doesn't have all the parts yet. He has the one index but not the right switch sections. Now you can see even if any one got interested enough to build he would be discouraged before he got started because he would not be able to buy the parts.

The reason most supply houses don't want to handle parts is due to the fact that they must invest too much money in stock, which is slow in being returned to them. Take the case of the above switches. In order to buy direct from Centralab the dealer would have to invest $1500. Now imagine how much money he would have to spend in order to have a good selection of parts such as resistors, condensers, transformers, tubes, etc. So now you can see why we have appliance operators and will continue to have them. The parts houses want them because there is more profit and faster sales with an already manufactured piece of equipment which is usually well constructed, debugged and ready for the power plug. So you can see an appliance operator is one by necessity rather than by choice and this doesn't mean that just because he is one, that he is not technically minded or a good operator.

Well Wayne since our incentive bands are already over crowded, I plan to work 160 meters again this winter where all the gang are all good guys and by the way there are quite a few old timers on the band. Also during December, January, February and maybe March depending on conditions DX can be worked on this band. Also I plan to work two meters and I will work any one no matter what class of license he may have. Ten meters is also a good band at night for local contacts. I don't hear too much activity here. Those fellows on 75 meter phone at night are mostly having local contacts and usually with very heavy QRM, heavy QRN, and need considerable power to get through. They should use ten meters thereby keeping it occupied so we don't lose it to other services.

Well, Wayne keep in there fighting. We need more like you.

Russ Lee W3GGY
Royersford, Penna.

Dear Wayne:

The stories in the November issues of CQ and QST seem to give slightly conflicting information as to just who gets the credit for the work done by Dr. Sam Rosen (WA2RAU) in winning the tower case against the city of New Rochelle. It doesn't seem right for both the ARRL and the Communications Club of New Rochelle to hold off for a year and a half and then step in—especially galling was the part about the fine job done by the ARRL. Maybe a fine job was done by Dr. Rosen, but no credit should go to the ARRL.

C. E. Monson WA2RWP
Geneva, New York

Dear Wayne,

At our local radio club meeting recently an effort was made to raise our dues for forced membership in the ARRL. I strongly objected to being forced to join the ARRL to stay a member in good standing of the local club, which hasn't been affiliated with the League for a score of years. The whole mess was instigated by the Area Emergency Coordinator who attempted to awe the uninitiated as to the works of the Great White Father of Amateur Radio. It was stated that they maintain a lobby in Washington and a big battery of lawyers who rush forth and rescue anyone that may be legally challenged by neighbors who object to antennas, interference, etc. Also, most locals believe that they cannot operate outside AREC during an emergency and have on this basis dropped out of well organized independent nets so they won't be off the air come the next hurricane. This lie has caused one net to fold and kept others from developing. We need help and advice.

Harold Lami K4GGV
Mobile, Alabama

No wonder your club members are confused. Apparently many ARRL officials have been spreading the lies and distortions you have run against. They have even been printed in club bulletins and semi-official League mouthpieces such as the Washington Amateur Radio News and Autocall. Much of this confusion can be cleared up by the expenditure of 10¢, half of it for a little government pamphlet entitled, "Federal Regulation of Lobbying Act." This costs a nickle from the Government Printing Office . . . the other nickle is your postage. Publication 78418 O-62. This Act is most specific. It sets forth heavy fines and imprisonment for any persons, societies, companies, etc., who in any way attempt to influence the passage or defeat of any legislation of Congress without being registered with both the House and Senate. The ARRL is not now and never has registered with either body and therefore is forbidden by law from any attempts whatever to influence Congress. The Institute of Amateur Radio registered with the House and Senate, starting in 1964, and is the only amateur radio organization that is so registered. So much for the League trying in any way to influence Congress. You can bet that their counsel in Washington sticks to his business of dealing with the FCC and nothing else. As proof of this, when the League was threatened with a libel suit recently as a result of an incredible blunder by the General Manager, outside counsel had to be hired for the case. Now, regarding the big battery of lawyers that rush forth to help beleaguered amateurs . . . those of you who know someone still getting CQ can ask them to read you the trials and tribulations of WA2RAU on page 59 of the November issue wherein he exposes the myth of ARRL legal help once and for all. All you get is a mimeo list of cases for the lawyer you have hired with your own money to use to look up past court actions. From there you are on your own. The Institute of Amateur Radio is the ONLY organization that provides funds for amateurs fighting legal battles that could affect us all if lost. We think that it is a crime that the League refuses to help amateurs in legal difficulties and the Institute is trying to fill this desperate need. During official emergencies amateurs are asked to keep off the emergency channels unless they are handling emergency traffic. This certainly does not mean that they cannot operate as much as they like outside of these designated channels. I hope not all EC's are as completely misinformed as yours. The Institute of Amateur Radio is the ONLY organization representing amateur radio in Congress and the ONLY organization lobbying for amateur radio.

Dear Wayne,

Can't you do anything to stop all these DXpeditions? There are now four fellows who are working full time at the DXpedition business and hardly a day goes by that from one to three of them are not on the air from some minor protuberance of the earth. The result is that twenty meters (and the other bands) are in a constant uproar, often with over half of the phone band taken up by thousands of stations calling by the hour. I heard one serious DXer brag that it took him 16 solid hours of calling to finally work 1S9WNV. Serious means qualified for the nut hatch, by the way.

Yes, I know that this is all the result of that abomination, the DXCC, but when I write to the ARRL I get nauseous at the pious cliches I get back from that bunch of idiots. Isn't there one single active ham on the ARRL staff? *Do* something, Wayne. Get these DXpeditions off our backs.

An Old Timer

Dear Wayne:

The question you have raised relating to the identification of the operator, as opposed to the station from which the signal originates appears to present no insurmountable obstacle. A simple change to para's 12.28 and 12.82 of the rules would provide a solution to the problem.

When an amateur radio station is operated by a licensed radio amateur, transmission of the station call alone merely identifies the station. It must be assumed that the station is being operated by the station licensee. No provision is made in the existing rules for identifying a licensed radio operator other than the licensee of a station being operated.

It is desirable to identify both the operator and the station when the call sign of the operator is not the same as the transmitting station. This applies specifically to club stations, but also to any station where a guest operator is using the equipment. I think the IOAR should approach the FCC with a suggestion based on the following:

When an amateur radio station is operated by a licensed radio amateur whose call sign is not the same as that of the station being operated, the call sign of the station should be transmitted followed by the fraction bar character DN and the call sign of the radio mamteur making the transmission, as for example:

Amateur operator with call sign W1ABC is operating Club station W1XYZ and calls W3DEF:

"W3DEF W3DEF W3DEF DE W1XYZ DN W1ABC W1XYZ DN W1ABC W1XYZ DN W1ABC AR"

Eric Young
Kent, Washington

Dear Wayne:

This will acknowledge receipt of your check for $40.00 for the Twoer Talk manuscript. I am proud to have my material appear in 73 Mag. It's still the best journal for my money (even if I don't agree with some of the editor's viewpoints, Hi!).

Doug DeMaw W8HHS (W1CER)

Part II: The Local Oscillator

Bill Hoisington K1CLL
Peterborough, N.H.

The 1215 Transistor Superhet

This article also describes a number of other transistor oscillators for test use from 28 to 1300 mc

Last month I discussed the mixer for a solid state 1215 mc superheterodyne receiver. You ought to have that mixer about ready to go now, so you can start on the local oscillator. This article is devoted to transistor oscillators for all the ham bands from 30 to 1300 mc, as the information gained in building these oscillators leads up to the last one described, the tunable local oscillator for the 1215 mc receiver. Next month's article, the last in this series, will be devoted to the *if* strip, the audio and the assembly of the solid state receiver.

This article will describe the following tunable oscillators:

1. A 28 mc signal generator for aligning the 28 mc *if* amplifier.
2. A 50 mc oscillator that lights a bulb with a low cost transistor.
3. A strap line oscillator for 140 to 300 mc.
4. A boxed-in oscillator for 250 to 500 mc.
5. A half wave unit for 800 to 1100 mc.
6. Two 1200 to 1300 mc oscillators. One is the receiver local oscillator.

An untuned UHF detector and a phase shift audio oscillator for modulating the oscillators is also described.

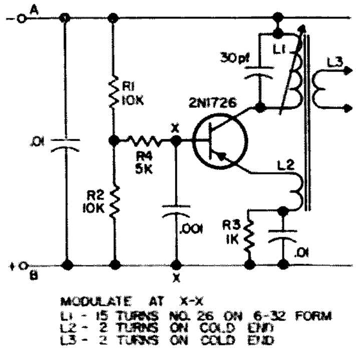
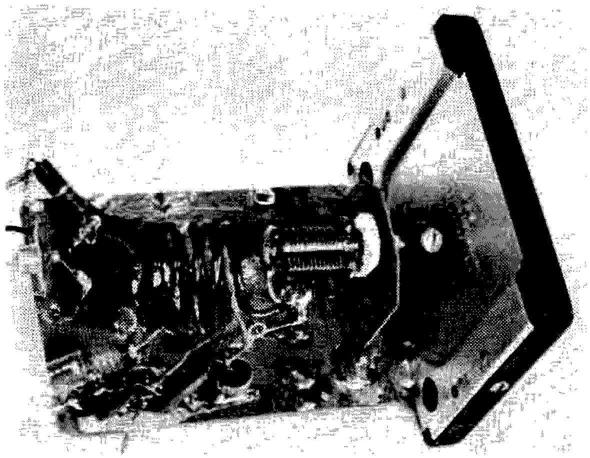


Fig. 1. 28 mc transistor oscillator.

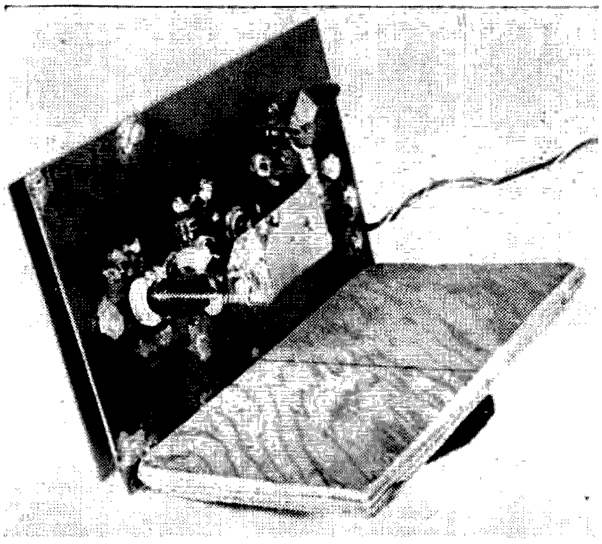
28 mc oscillator

This circuit (**Fig. 1**) is good from 1 to 50 mc. Note that no ground is shown. As you go up in frequency in VHF and UHF, remember that the only possible definition of ground is a place where there is no RF. A ground—such as battery case, metal panel, Minibox or the outside sheath of coax—can be connected to either A or B, but not both! This is very useful for mobile, of course.

L3 is a low impedance link for taking some of the power developed and putting it to use. You can tune the unit either with the iron core or with a variable capacitor across it. An impregnated paper coil with internal 6/32 threads and a powdered iron core with similar threads make a handy and very small assembly. Insert the core from the cold end for



Back view of the 50 mc oscillator shown in Fig. 2.



140-300 mc strap line oscillator.

best results. Use a 1 k emitter resistor (R3) and you are pretty sure not to burn out the transistor. You can reduce R3 for more power, but don't go too far. R1 controls the bias on the transistor base, so I often use a pot there and adjust for best results. Watch the collector current while you do that, though! The $1.15 Sprague 2N1726 does fine here and up to several hundred megacycles. Many other inexpensive transistors will also do.

50 mc oscillator

The circuit of **Fig. 2** works very well with a Sprague 2N1726 on six meters. It's recommended for local oscillator service with a collector current of about 2 ma for a total input of about 18 to 24 mw. Both base and emitter feedback were tried. Both work well, but the base feedback circuit shown seems to give more power. But some makes and types of transistors show greater or lesser variations between the two feedback methods.

Since this is a test oscillator, a front panel with dial was used. Place the one or two turn feedback coil L2 within the first turn at the collector end of L1. A very small capacitance

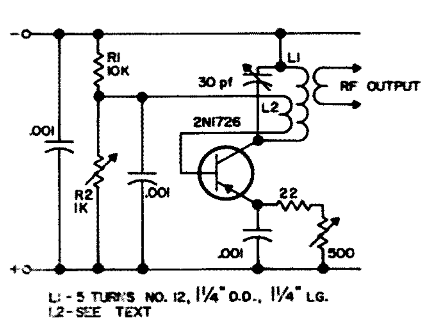


Fig. 2. 40-75 mc oscillator.

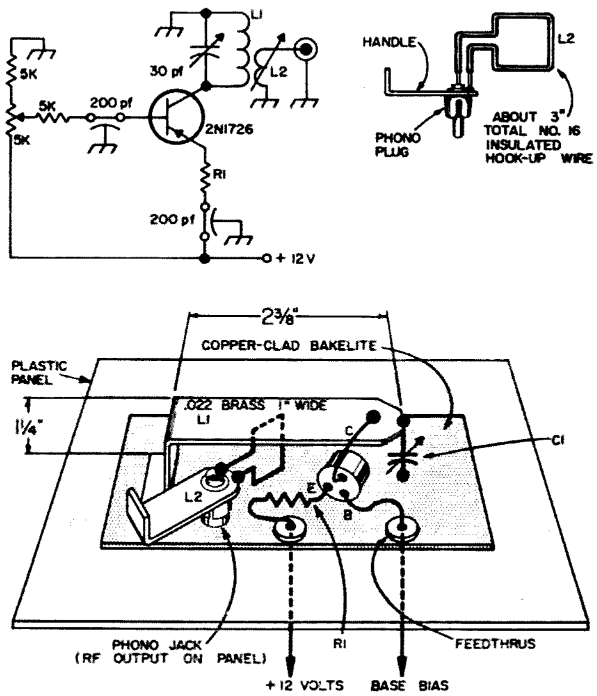


Fig. 3. 140-300 mc strap line oscillator. R1 is 1 k.

(a short length of hook up wire) between base and collector helped with some transistors, even though not needed by theory.

This is a very strong oscillator. I was unable to cut it off fully by pressing my fingers around L1. It also oscillates with less than 2 volts at 50 mc. Just for fun, I paralleled the 2N1726 with another 2N1726. Then I connected a #48 pilot bulb across a turn of L1. Collector current doubled nicely and the bulb was lit with a very faint glow. A third was added for an even brighter glow (maybe 70 to 100 mw) with no complications. I also tried a Motorola 2N3266. It lit the bulb with one transistor and two gave more power. Not bad for low power receiving transistors!

140 to 300 mc oscillators

Now we start using strap line circuits. You can use strap wound coils, but strap lines work so well, why bother? **Fig. 3** gives the circuit and layout. What could be simpler or neater? A quarter wave line with the collector across the hot end, base bypassed right through the ground plane, 1 k resistor in the emitter and output jack variable to your heart's desires. A 2N1726 works fine, but a 2N2360 is a little livelier at 300 mc. Note that you can put the base bias pot on the panel or in a separate box. This unit was left in the open, but could be put in a box like the next oscillator.

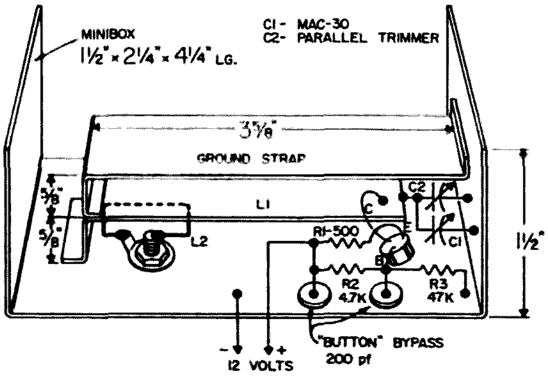
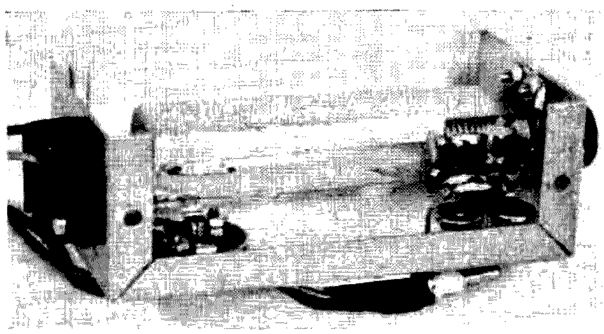


Fig. 4. 250 to 500 mc boxed oscillator. C2 is about 5 pf.



250-500 mc boxed oscillator.

A real simple gimmick for variable output is shown as a detail in **Fig. 3.** It's the output link L2. You can use a panel in front of the copper clad bakelite and mount a phono jack on it for removing RF. Stability of the oscillator is quite good. You can even get a clean beat with a communications receiver BFO as tuned in with a two meter converter. Just don't bang the table!

250 to 500 mc oscillator

Fig. 4 shows an oscillator tuning 250 to 500 mc. The same type of circuit will go up to around 700 mc with a little fussing. You can bandspread it anywhere in the region with the use of C2, about 5 pf, by dropping the value of C1. The emitter resistor is reduced to 500 ohms for a little more gain to overcome increased losses at UHF. The circuit is similar to the one in **Fig. 3,** except for the added encircling ground strap, which was discussed in last month's article. At these frequencies, the 2N2360 works very well. You can put this oscillator in a Minibox if you wish, with the battery in another box. Don't ground either side of the battery, though, or you may run into problems with PNP and NPN transistors. The 2N2360 runs at about 2 ma collector current.

850 to 1100 mc half wave oscillators

Just like in the 6AF4 tube oscillators in the 1215'er (May 73, page 72), at a certain frequency you have to abandon quarter wave lines and go to half wave straps, two of them: one for base and one for collector. This oscillator is shown in **Fig. 5.** It tunes 860 to 1120 mc as shown. Attach the collector and base resistors (R2 and R1) to the lowest points of rf. You can find them by placing an untuned detector near the tuned circuit with temporary connections and touching the lines with a pencil point. Attach the resistors where the pencil has least effect on output. The construction of this oscillator is quite experimental. I didn't use a ground plane but just a plastic base and capacitor support.

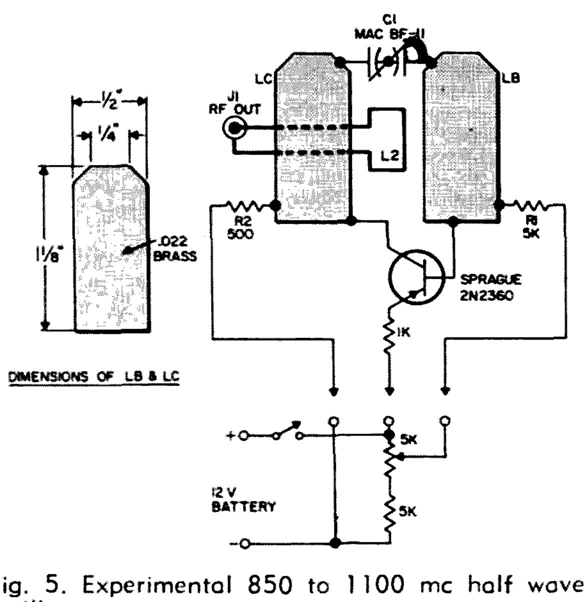


Fig. 5. Experimental 850 to 1100 mc half wave oscillator.

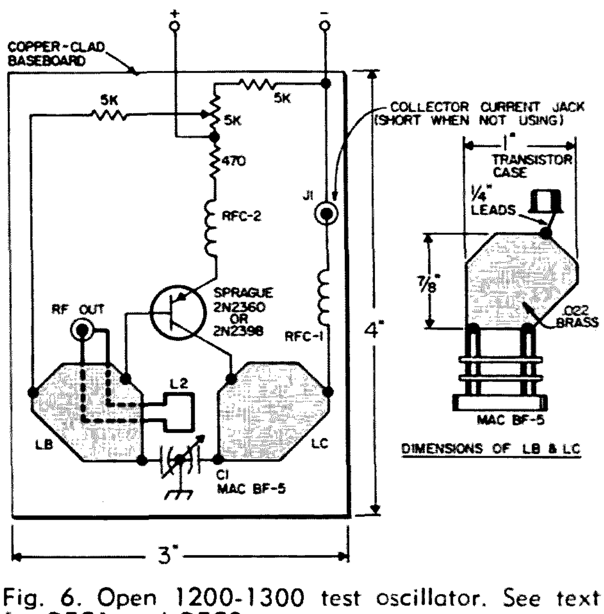
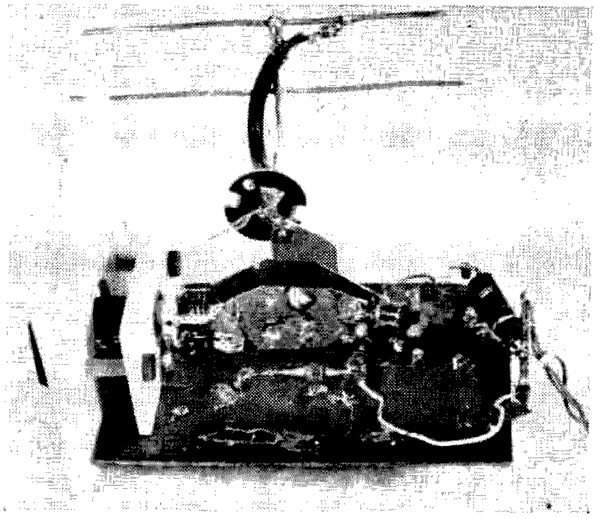


Fig. 6. Open 1200-1300 test oscillator. See text for RFC1 and RFC2.



Open 1200 to 1300 mc oscillator. The antenna is for test use.

1200 to 1300 mc oscillator

This oscillator, shown in **Fig. 6,** is an open type which is used here for generating signals, antenna testing, etc. It is similar to the one shown in **Fig. 5,** with changes to bring it up the 1200 to 1300 mc region. RFC1 brings the DC to the collector with less loss than the previously used resistor. RFC2 is a little touchy. I have used bare wire, strap, chokes, etc. Use a small coil or what you want. You'll probably have to adjust it for best results. I ended up with 1¼ inch insulated wire. You can tune it for best output by mov-

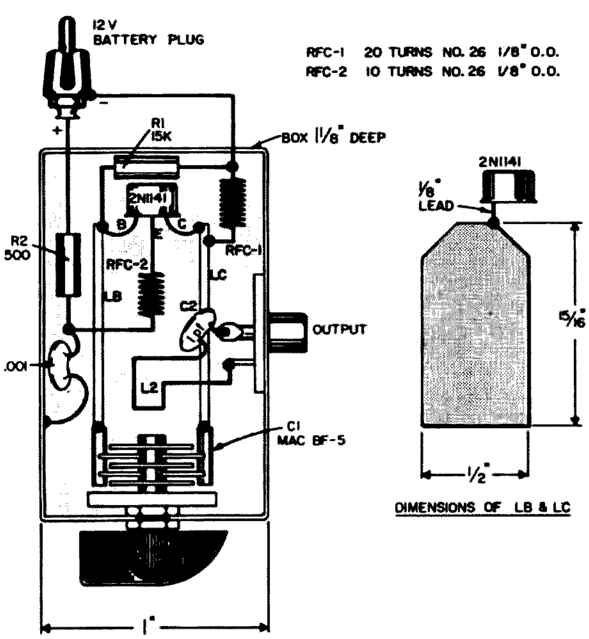


Fig. 7. The 1215 local oscillator.

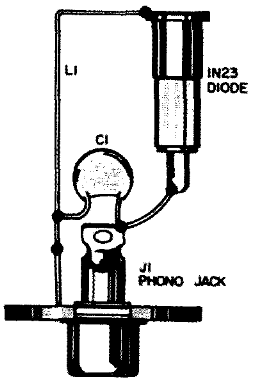


Fig. 8. UHF untuned detector. C1 can be 100 to 1000 pf.

ing a small square of copper foil near and up it. Do this while watching an RF meter, such as the one described later in the article. LC and LB are spaced half an inch from the base plate and 5/16 inch from each other. C1's ground connection is a half inch wide copper strap about ⅜ inch long. The shortest possible leads were used on the transistor. I use very small pliers to hold the leads close to the case and have had no trouble so far.

The RF output jack should be mounted on a piece of insulating material, as this circuit is quite touchy about any metal connected to the base board near the lines. You can see that 2¼ inch wire is a quarter wave vertical antenna at 1300 mc and pieces of metal will absorb power like a sponge. Don't go over about 2 ma. Remember that the total dissipation of the 2N2360 is 60 mw.

Solid state local oscillator

This is the main feature of the article and will be concerned with the physical details of packaging the oscillator of **Fig. 6** in a small box. A 2N1141 was used in the local oscillator shown in **Fig. 7.** It has a higher capacitance than the 2N2398 or 2N2360, so LB and LC get real short. You could also use a 2N2398 and longer lines.

I built it in a .022 brass box. I didn't bend the brass, just soldered it together. The oper-

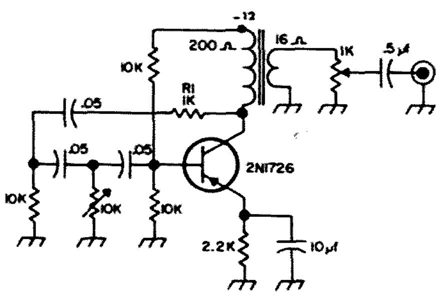
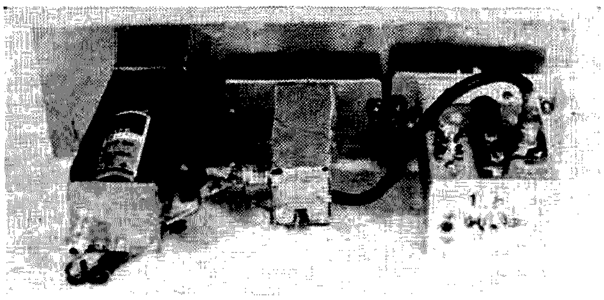


Fig. 9. 1000 cycle modulator for the oscillators.



Back view of the battery case, local oscillator and mixer of the 1215 superhet.

ation is similar to the last two oscillators, but collector current can be as high as 4 or 5 ma. You can adjust R1, but make sure that you keep at least 5 or 10 k in series with the battery. Don't want to blow out more good transistors.

Untuned UHF detector

Here's a useful gimmick shown in **Fig. 8.** It's an untuned detector that consists mainly of a 1N23 type crystal diode detector. C1 is a tiny Lafayette capacitor. Measures just over ⅛ inch square. It can be any value from 100 to 1000 pf. It does a fine job from 420 to higher than I've been yet. L1 has a total of less than one inch. I soldered right onto the crystal case—though I'm sure that the engineers who designed it will turn over in their graves! I generally use it with a large dial 0-500 μa meter with the detector about half an inch from the oscillator lines. It's quite sensitive.

Modulator

The audio oscillator shown in **Fig. 9** does a good job of modulating the RF oscillators shown. It has an adjustable frequency trim for centering on 1000 cycles, which is used by some test equipment. It also has a volume control on the amount of modulation. The .5 μf coupling capacitor will drive the base of the transistor without modifying the base voltage. This oscillator seems to work better than any other one I found.

Conclusion

This article has described a number of useful transistor test oscillators. One is used as the local oscillator for the 1215 superhet receiver that I've been describing. The final installment of the receiver, the *if*, audio and assembly, will be covered next month.

. . . K1CLL

Paul Franson WA1CCH
Peterborough, N.H.

Vibrator Checker

Most hams would like to have a spectrum analyzer, twelve gigacycle wavemeter, and 5 kw dummy load for 420 mc. Then they could build their own gear instead of making Collins rich. But cost, complexity, and infrequent use keep them from owning the above, as well as some more exotic test gear. Here's a piece of test equipment that you won't use much, but it's so simple and cheap that it's silly not to build it. It checks vibrators (as you know if you read the title).

Parts List:

1 vibrator (4 pin) socket.
2 # 51 or similar pilot lamps.
2 grommets.
1 case (use your imagination!)

Obviously, if you use another type of vibrator, you have enough sense to use another socket. You don't need lamp sockets, mount them in grommets and solder to the terminal and shell. A built in voltage source (a 12 volt center tapped transformer) is ideal, but hardly necessary. You can steal the voltage for the short time you'll need it. **Fig. 1** gives the circuit.

Interpretation of results and Testing procedure: Attach the proper voltage source (6 volts for a 6 volt vibrator, *etc.*) Plug in vibrator.

1. If the two lights are of equal brilliance, it's good.
2. Uneven brilliance. Questionable. Hit on table a few times or use twice normal voltage for a minute or two.
3. One or both lamps dark. Try procedures under 2. If no luck, put in power supply you're about to trade. If you can't unload it, open carefully with pliers or teeth. If the reed is stuck, unstick. Try again in tester. If contacts are dirty, clean carefully with suitable abrasive (wife's nail file, emery board, a two dollar bill, *etc.*) Try again. If still no luck, you've got a 4 prong male plug, a puller for miniature tubes, a shield can or ashtray, plus! some ceramic or other insulators and some fine wire. If there are three insulators and enough wire, you've got a dipole that is excellent if your transmitter causes TVI and you want to hide the antenna.

Finally, if you've had to play around to get the vibrator to work, you shouldn't use it in critical equipment. All vibrator manufacturers advise you not to try to fix or adjust vibrators (After all, they want you to buy a new one!) But they're fine for most ham use. And even a bad vibrator is good for generating hash to adjust noise limiters and ratio detectors. So build it up, get some vibrators (perhaps from a local repair shop) and then you can brag about your interest in building and the technical side of the hobby.

. . . WA1CCH

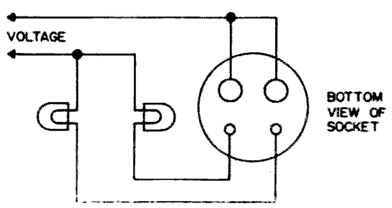


Fig. 1. Schematic of the vibrator checker.

HOT SCOOP: The Texas Instruments TI-XMO5 germanium PNP mesa transistor selling for 52¢ apiece in single quantity is consistently the quietest 432 rf stage we have seen in transistors selling for under $15. See an upcoming article in the VHF'er for details.

. . . WIOOP

Henry Cross W1OOP

Low Noise UHF Transistors

Here is a list and graph I have compiled of all the UHF RF stages that I have been able to get data on. The high priced items seem to me to give us a taste of what we'll be getting for a couple of bucks by 1968.

So far, we can say:

1. Transistors are quieter than tubes above 150 mc.
2. Transistors are quieter than crystal mixers below about 800 mc (unless you are very rich, in which case read 1200 mc.)
3. Germanium or silicon—it's a toss-up in practice.

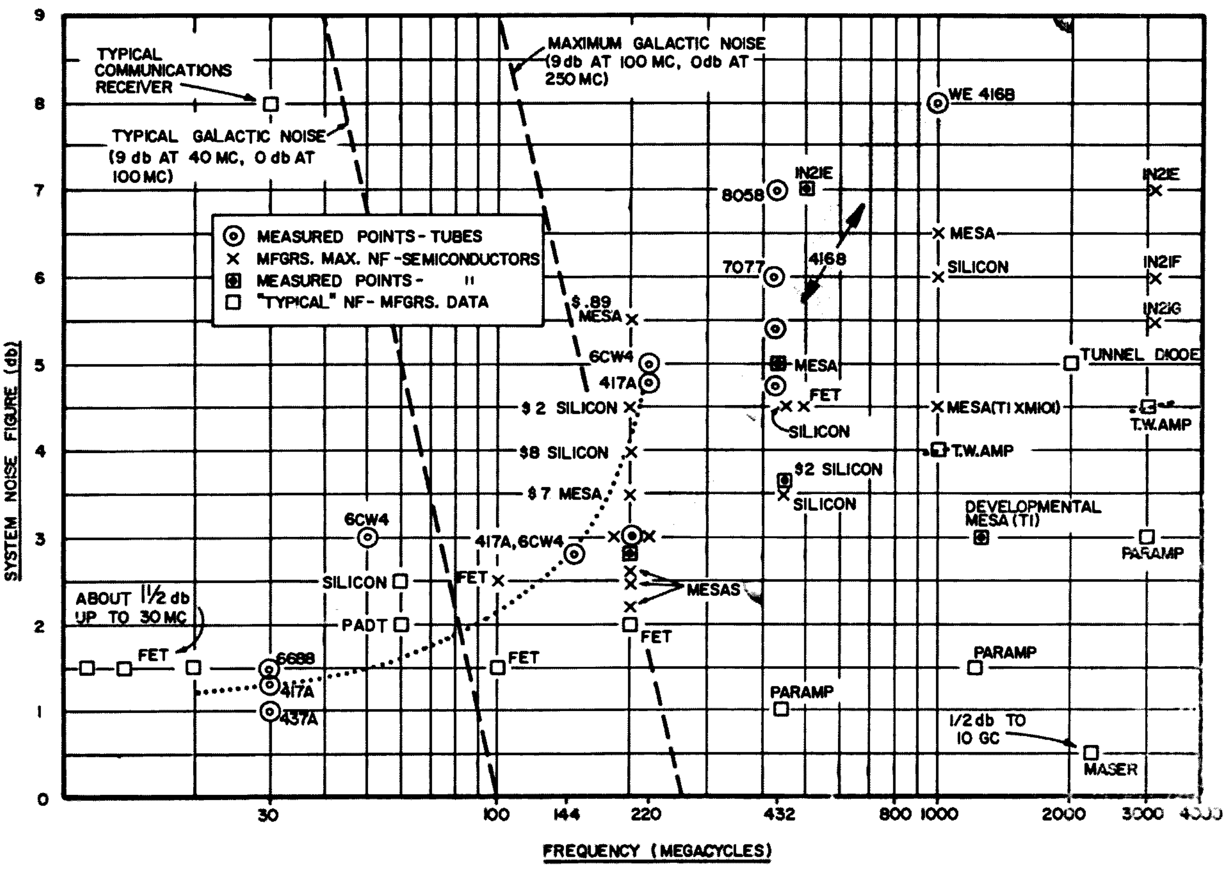
. . . W1OOP

Current UHF Low Noise Transistors

Mfg.	Type	Wrk Col Volts	Max NF 200 mc	Other info	Price
A. PNP Germanium (mesa)					
TI	XM101	9	2.6	4.5 db max NF 1 Gc	19.00
MOT	2N3783	10	2.2	6.5 db max 1 Gc	45.00
MOT	2N3784	10	2.5	7.0 db typ 1 Gc	30.00
MOT	2N3785	8	2.9	7.5 db typ 1 Gc	15.00
MOT	MM2503	6	3.0	2.4 db typ 200 mc	26.25
MOT-TI	2N2415	6	3.0	2.4 db max 200 mc	26.25
TI	2N2999	6		7 db max 1 Gc	75.00
TI	2N2998	6		8 db max 1 Gc	52.50
TI	2N2997	10	4.5		3.38
TI	2N2996	6	5.0		1.48
MOT	2N3279	10	3.5	2.9 typ	7.50
MOT	2N3280	10	3.5	2.9 typ	6.75
MOT	2N3281-2-3	10	5.0	4.0 typ	4.50-4.05-2.10
MOT	2N3307	10	4.5	Silicon PNP. OK to 25 v CE & 100°C	10.50
Philco-Sprague	2N2398-9	10	4.5	Different packages	3.45-3.35
TI	TI-400	6	5.5	4.5 db typ 200 mc	89¢
Amperex	2N3399	10		5 db typ 400 mc	2.55
B. NPN Silicon. Mostly diffused planar.					
KMC-RCA	2N2857	10		4.5 db max 450 mc	18.00
KMC	2N3683	10	4.0		8.00
KMC	2N3880	10		3.5 db max 450 mc	
RCA	2N3478	10	4.5	2.5 db typ 60 mc 5 db typ 450 mc	1.90
TI	TIX3015	10	—	2.4 typ 200 mc 6 typ, 7 max 1 Gc	high
Fairchild	2N3339	10	5.5	—	18.00
Fairchild	SE3001	6	—	—	75¢
C. FET's					
KMC	K-1001	10	4.5	4 db typ. Source stepped up to 200 ohms	30.00
KMC	K-1201	9	—	4.5 db max 450 mc	63.50
KMC	K-1501	15	5	—	—
TI	2N3823	15		2.5 db 100 mc 4.5 max 500 mc	12.90

FET's are high input impedance low transconductance devices. The K-1001 could be used in place of a vacuum tube in some circuits, though its gain is about 6 db lower than a 6CW4.

Mfg.	Type	Wrk Col Volts	Max NF 200 mc	Other info	Price
D. Tubes					
	6CW4	70		5 db typ 200 mc	2.23
	416B	250		5 db typ 450 mc	54.00
	7077	150		6 db typ 450 mc	33.75


TYPICAL COMMUNICATIONS RECEIVER
TYPICAL GALACTIC NOISE (9 db AT 40 MC, O db AT 100 MC)
MAXIMUM GALACTIC NOISE (9 db AT 100 MC, 0db AT 250 MC)
MEASURED POINTS - TUBES
MFGRS. MAX. NF - SEMICONDUCTORS
MEASURED POINTS - "
"TYPICAL" NF - MFGRS. DATA
WE 416B
IN2IE
8058
7077
416B
MESA
SILICON
IN2IF
IN2IG
$.89 MESA
6CW4
417A
$2 SILICON
$8 SILICON
$7 MESA
FET
TUNNEL DIODE
MESA(TI XMIOI)
T.W.AMP
$2 SILICON
DEVELOPMENTAL MESA (TI)
PARAMP
6CW4
417A,6CW4
SILICON
MESAS
ABOUT 1½ db UP TO 30MC
PADT
6688
417A
437A
1/2 db TO 10 GC
MASER
SYSTEM NOISE FIGURE (db)
FREQUENCY (MEGACYCLES)
0
1
2
3
4
5
6
7
8
9
30
100
144
220
432
800
1000
2000
3000
4000

NEWS FROM THE INSTITUTE OF AMATEUR RADIO

Compiled by A. David Middelton W7ZC, Secretary

Institute Of Amateur Radio

The big news of the month . . . no, of the year, for the Institute is the appointment by the Directors of David Middelton W7ZC/W5CA as Secretary of the Institute. One of the major problems suffered by the Institute was the dependence on me for getting letters to Congress, letters to members, and all the other important work of the Institute done. Now, with Mid at the helm, ably directed by our Directors, the Institute will enter 1966 in a very strong position.

Mid has an interesting background that he brings to the position of Secretary. He is a senior member of IRE, the First Vice President of AREA, a member of the OOTC, the Morse Telegraphy Club, and ARRL since 1923. He is a past Director of the League and an ex-editor of QST. The list of his activities could go on for several pages for he is interested in many things and has taken an active interest in many projects and clubs. He has been licensed since 1921 and held the Extra Class license since 1928.

Mid will be preparing the letters to Congress about Amateur Radio and coordinate the representation of amateur radio in Washington with our Directors there. Mid will keep in touch with Institute members through a series of confidential letters giving the inside dope on what is really going on behind the scenes and through a more general series in the monthly report in 73 Magazine.

Most well informed amateurs throughout the world are looking anxiously to the Institute and to Mid for the preservation of our hobby.

Open Letter to all Readers of 73

It is with great joy and pride that I accept the post of Secretary of the Institute of Amateur Radio.

It is my hope that with the guidance and help of the IoAR Directors, combined with assistance and suggestions from every one of you vitally concerned with Amateur Radio, that I may carry out the complicated task of implementing the work of IoAR.

Those of us charged with the administration and organization of the Institute can only lay the ground work and set the stage for its full operation and the utilization of the Institute's potential capabilities. The actual "performance" must be given by IoAR members and supporters. And, that is where YOU, the readers of 73 may assist.

Institute Members will regularly receive, thru direct mail, detailed reports of the IoAR, and space in 73 will be devoted to generalized information on the overall workings of the IoAR that effect the whole body of Amateur Radio.

If you are not now a member of the Institute, and if you are thoughtful about the present and future status of your chosen hobby—Amateur Radio—then we heartily welcome you to our ranks. If for any reason you choose not to become a member of IoAR, please study the contents of these official IoAR columns in 73. Rely upon such information as being factual—regardless of what you may hear or read otherwise. It is our intention to present FACTS and only facts regarding IoAR and its relationship with Amateur Radio.

It is our hope that you will do us the courtesy of *non-prejudicial* thinking until you have digested the official IoAR information presented.

Correspondence concerning any phase of IoAR activity or Amateur Radio will be welcomed. Crack-pot and anonymous letters will receive the treatment they deserve—a quick toss into the Round File. All others will be answered as completely and promptly as possible. SASE will be appreciated, as they will save time and IoAR money.

Visitors at W7ZC are always welcomed by my wife Charlet and myself. Living only 1000 feet from State Road 15 leading directly into beautiful Zion Park (2.5 miles north of W7ZC) we are fortunate to have many hams and their families stop by. Zion Park is open all year round and is fabulously scenic at any season.

If you get out this way—stop by W7ZC and we'll talk about at least two things of mutual interest—The IoAR and Amateur Radio!

IoAR—Totally Dedicated to the Betterment and Preservationof Amateur Radio.

Meanwhile, watch for W7ZC on the bands, on both CW and SSB as I will continue to be as active as possible along with my duties as Secretary of the Institute.

. . . W7ZC/W5CA

Progress Report—the IoAR to Date

A brief history of the Institute is in order.

The IoAR was founded on August 28, 1963 by a group headed by Wayne Green, who believed that Amateur Radio needed to be better represented and that only by providing direct public relations information to those who rule over our destiny, (the governmental agencies and public officials) could we hope to preserve Amateur Radio.

International friendship and technical achievement thru the medium of Amateur Radio was also in the thoughts of those starting IoAR.

The State of New Hampshire, on April 6, 1964, granted the Institute its approval and charter. The articles of agreement were signed by Mr. and Mrs. Wayne Green W2NSD/1, (he is owner and editor of 73 Magazine) Val Barnes W1ALU; Dan Lester W1AER; and Ted Shapas K9YOE.

The Institute is chartered as a *non-profit organization*, no capital stock is issued, and the official object of the IoAR, as stated in Article 2, is "To further technical achievement and world friendship through the medium of Amateur Radio."

The Institute started in a small way, without fanfare and sans much publicity, even in 73. It grew slowly and gained strength through its activities, mainly that of establishing public relations contact with the entire FCC, Senate and Congressional personnel by direct mail reports on the GOOD side of Amateur Radio. Some ten thousand pieces of such literature have been distributed *where it helps*, by the IoAR.

Response has been gratifying! Many communications have been received from the recipients of this IoAR-originated publicity. Many of these persons had never had any direct information from an Amateur Radio organization and had only received their news second-hand and often distorted.

The Institute established its "Man in Washington," and publicized his availability to answer questions and to supply further accurate information. The IoAR applied for and received *official* recognition as a lobbyist for Amateur Radio, and continues to file the required reports to maintain its legal lobbyist standing.

Important IoAR Addresses

For all correspondence except that regarding membership and supplies:
Institute of Amateur Radio
Springfield, Utah 84767

For membership correspondence and IoAR supplies:
Institute of Amateur Radio
Peterborough, N.H. 03458

No other Amateur Radio organization is officially recorded as a lobbyist, and therefore none other than IoAR can legitimately REPRESENT Amateur Radio in Washington circles, nor can they legally expend money to lobby for Amateur Radio in *any form!*

The Institute so far has been busy with activities that have not had much direct effect on individual members. This is acknowledged and deeply regretted, but was unavoidable due to lack of personnel, finances and pressure of other duties on Mr. Green, and on many of his associates.

A group of nine INTERIM DIRECTORS was chosen for the IoAR. They are—Bill Ashby K2TKN; Wells Chapin W2DUD; Lloyd Haslam W3AYA; Maurice Hinden W6EUV; Harry Longerich W2GQY/4; Edwin Schaad WA4PDX; Foy Guin W4RLS and Howard Pyle W7OE. The IoAR Secretary is A. Davide Middelton W7ZC/W5CA.

It should be noted that none of the original signers of the Articles of Agreement (with the State of New Hampshire) are Officers of the IoAR. These signers of the Articles were

INSTITUTE OF AMATEUR RADIO
MEMBERSHIP APPLICATION

(Use separate sheet if desired)

Name . . . . Call . . . .

Address . . . .

City . . . . State . . . . Zip . . . .

. . . .$5 enclosed for one year membership in the IoAR.

. . . .$7 enclosed for IoAR membership and one year of 73.

. . . .I am a new member of the IoAR.

. . . .I am a Charter member and desire to have my membership continuous.

Institute of Amateur Radio
Peterborough, N.H. 03458

the *originators* of an idea and some ideals which later became The Institute of Amateur Radio.

The Interim Directors have given council, furnished guidance and advice on every phase and every step of the progress of the Institute.

At the present time, a Constitution and By Laws has been hammered out, is being revised for final presentation to the IoAR Members for ratification. It is expected that the C & BL format may be in the mails to the IoAR Members by the time this appears in 73. Following approval by a majority of the members or after any further changes as are made as deemed necessary, it will become effective.

In the meantime, work at IoAR continues apace. Among the first tasks assigned to the new full-time Secretary is the preparation of a descriptive booklet—"IoAR—WHAT, WHY, WHO"—that will contain detailed information on the basic structure, aims, goals, plans and work of the IoAR, both for the present, the immediate and the far-reaching future.

Another task, and one of vital concern, involves the coordination of the activity of the individual IoAR member into the entire IoAR community to better utilize his or her effort to BUILD IoAR and to assist those who have carried the load so far along the way. Another task is the evolvement of ideas along the lines of technological achievement awards; and club and Chapter affiliation with IoAR.

Still other tasks include the never-ending Public Relations releases with a broadened approach and presentation of this vital work; plus the Institute's constant effort to assist in the fight against unjust persecution of Amateurs through local nuisance and ordinance suits!

These are only a few of the things being worked upon at IoAR Headquarters and by individual Directors and members.

The IoAR is doing this work for Amateur Radio and ALL of us will benefit, in one way or another, from these coordinated IoAR efforts on behalf of Amateur Radio. Will you help us?

A Statement of IoAR Policy

This issue of 73 brings to its readers the first in a new and continuing series of official IoAR columns. Wayne Green has generously donated, free of charge, two full 73 pages monthly for the use of the Institute. This space will be used for information of general interest to 73 readers who are potential members of IoAR. Institute Members will regularly receive IoAR reports directly, by mail.

It must be made clear that there is no connection between the policies of 73 Magazine and those of the Institute except that *both* are dedicated to the betterment and preservation of Amateur Radio. There are no officers of the IoAR on 73 and no 73 Staffer is an officer of the Institute. The IoAR policies are completely determined and controlled by its Board of Directors and Members.

The Institute is indeed grateful to 73 Magazine for this welcome space and we hope that the readers of 73 will find the IoAR news stimulating and informative.

Be assured that the content of the IoAR News is completely accurate and that it reflects IoAR views and those of its members. It is suggested that 73 readers review and examine with considerable caution *any* references to IoAR in other publications and check their authenticity and purpose before accepting them as fact!

If you are desirous of reading previous 73 material about IoAR, please refer to the following issues, by date and page: January '63, page 2; Febr. '64, page 4; March '64, page 64; May '64, page 85; June '64, page 92; August '64, page 5; October '64, page 87; Febr. '65, page 2; April '65, page 32; June '65, page 15; August '65, page 88.

For additional information read this and subsequent "News from IoAR" in 73.

IoAR and "Two-Party" Ham Radio

The Institute of Amateur Radio is NOT anti-anything! It is FOR Amateur Radio and has not been created to fight any other group, activity, individual or collection of personalities in Amateur Radio. IoAR plans to establish, to implement and to carry out its OWN programs. It is not a "ME TOO" setup!

If other organizations have programs that are, in the opinion of IoAR, *good* for Amateur Radio—we will strive, to the best of our abilities, to further those programs. However, IoAR intends to establish and maintain its own position—regardless of the action taken by any other group.

IoAR will not knowingly enter into or publicize any assaults upon or comparison with, the *basic* fundamentals of other Amateur groups. IoAR may, naturally and deliberately, take exception to deviations from those *basic* concepts, editorially or politically!

These United States of America have survived and thrived on a multi-party political system. The founders and Founding Members of IoAR believe that such a system is

ıg *overdue* in the matter of national Amaır Radio policy-making, leadership and idance.

IoAR upholds the full right of FREE EECH and a FREE PRESS. IoAR deıres its privilege to challenge, at any ıe, any programs or views presented that inimicable to the underlying principles the Amateur Radio fraternity—those of endship, service and advancement of technological skills!

IoAR will not withhold its support and couragement from any bonafide intra-mural oup of Amateurs who are endeavoring to ıke our endeavor more exciting, challeng- and rewarding through their specialized erests and efforts such as CHC, countynting, DX, SSB, VHF, nets, and awards.

IoAR does not intend to publicize the ıtings and ravings of radicals, ignorant, lfish-minded individuals or groups who put eir personal operating desires or habits ove the common good. There is no place IoAR or in Amateur Radio for "sharpooting" or a political King Fish! Let's leave at to the professionals.

IoAR most definitely has no plan or proam to

—Become a GIANT in the Amateur Radio blishing field.

—Control the Amateur Radio advertising ırket.

—Permit usurpance of Amateur Radio freıencies by non-Amateur groups or interests.

—Foster complacency on the part of Amaurs, when our very existence is at stake ru lack of operational and technological ills.

IoAR *does* have definite plans for a proessive program for action at the operational ıd technical levels, designed to *upgrade* the nateur (through educational and explanary measures), which will bring new Amaurs into focus on the proper procedures hereby they too can enjoy and participate the Amateur service in the most efficient ıd proficient manner.

The Institute has a definite plan for recogtion of INDIVIDUAL effort and achieveent along in the Technological phase of nateur Radio.

IoAR is FOR any action and FOR any dividual or any group who is *doing someing* in a POSITIVE manner and direction ıat will enhance and preserve Amateur adio. IoAR welcomes fraternization with oups and programs designed to enhance the chnical or operational aspects of Ham Radio!

. . . W7ZC

Don Miller W9NTP
Waldron, Indiana

What's the Strength of Your Mobile?

There was one time in the ham life of W9NTP when I had $100 per contact invested in mobile transmitters. After years of experimenting, which included a 500 watt mobile AM station, two or three factors became evident which contributed greatly to successful mobile operation. Over this period, mobile contacts became commonplace and many countries of the world were worked. Most of these contacts were made on the crowded 20 meter band where QRM is bad. The three most significant factors contributing to successful mobile operation in order of merit are:

1. VFO operation
2. Field strength indicator in the car working continuously
3. At least 50 watts of power. AM operation was used in most of these contacts, but it goes without saying that SSB or DSB has much advantage.

VFO operation: There is something psychologically in favor of the mobile station who is able to zero beat a CQ from another station. After making hundreds of contacts, I have found that less than 10% are worked by calling CQ from the mobile. Perhaps the fixed station is flattered when the little mobile running along 50 mph hears his signal. If you have any doubts about this, keep track of your contacts for a month and see for yourself. It goes without saying that a stable vfo source is necessary. This is a sizable project for the average ham and apparently for the commercial manufacturers too, since very few commercial vfo's are stable enough to allow use in mobile DSB and SSB operation.

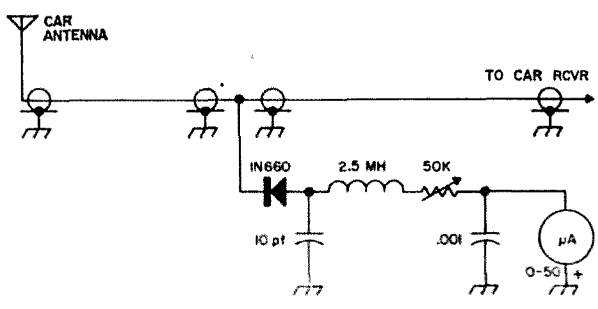


Fig. 1. Schematic of the mobile FSM.

The second factor is field strength measurement. Years ago, I built a combination field strength meter and S-meter for my 1949 Chevrolet. Immediately it became evident why I had failed to get out on some frequencies and it also pointed up the fact that the dip in plate current, so commonly used for tuning, was a poor indicator for maximum output. With a continuously operating field strength meter it is possible to tune for maximum output even if the antenna is near large detuning objects or leaning at a forty-five degree angle due to the forward velocity of the car. On the lower frequencies, seventy-five and forty meters, it will give an indication of how far you can operate from the resonant frequency of your antenna. I have even used the meter indication to tell me the charge state of my battery.

Naturally the obvious antenna to use on the automobile is the broadcast antenna. This is sometimes unused in a mobile installation when a converter is used. Many of us mobilers used the long amateur transmitting whip for broadcast reception when we wanted our injection of Rock and Roll, while the broadcast antenna was used for the field strentgh indicator. Anyone who has tried this with the new hybrid or transistor receivers is due for a shock. My broadcast receiver received a weather station near the *if* frequency so well that it blanked out broadcast stations. I finally decided to use the broadcast receiver with the antenna for which it was intended. If a con-

tinuously operating field strength meter is to be installed, it means that a separate antenna will be necessary or a circuit designed to work wtih one of the existing antennas. Since I have three antennas on the car now, the broadcast antenna was chosen to be the combination broadcast and field strength indicator antenna.

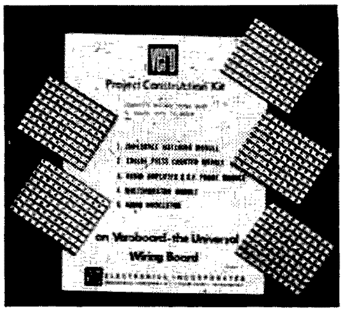
The circuit is mounted in a small 3x4x4 Minibox and secured behind the dashboard. A 1N660 silicon diode is used, because at the low microvolt levels at broadcast operation, the diode will not conduct due to its high threshold voltage. A 50 micro-ammeter was used for the indicator and with my particular installation I was able to mount the meter in the dash of my 1960 Chevrolet in the dummy hole which should have contained a clock. The addition of this meter actually improves the appearance of the dashboard. Although this installation was to be mainly used in the tune up of my 20-15-10 meter transmitter, I find that it reads extremely well on the 2 meter FM transmitter that I have installed for local communication. In addition, it draws out the radiation pattern of the local brodacast stations as I drive by. The normal reception of the broadcast receiver was not affected in any way. I did cut out as much of the low capacity antenna lead-in as I could in order to compensate for the addition of any capacitance from the diode and other circuitry.

I had been suffering along with the final plate current indication for maximum power output in the 1960 car installation, but when I installed the field strength meter, I immediately saw the fruits of my labor as I tuned up my transmitter on 20 meters during a Sunday afternoon and heard a bunch of California kilowatts complain of a strong heterodyne on their frequency. I immeditely identified myself and apologized for interrupting their local QSO. Before you desert mobile operation, try a continuously operating field strength meter and see the difference. I forgot to mention that a field strength meter in the home QTH will do as much for the fixed station as it does for the mobile. I just had a horrible thought; please don't all of you fellows build these meters or I'll have to put a second 6146 in the car.

Last of all, on the subject of power, I have found that 50 watts is the minimum power that true DX can be worked from the car. My 500 watt mobile installation was much better but not enough to make it worth the great effort involved. Fifty watts comes easy in a car because it is about the power range that can be handled without special power supplies. Let's all work WAC mobile!

. . . W9NTP

NEW PRODUCTS

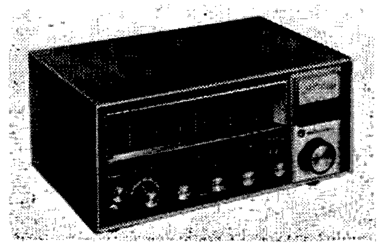


Veroboard Kit—$1.95

Been curious about Veroboards? Want to try a little project or two with them to see how they work? Here's a very inexpensive way to do it. The Vero Model PK-5 project construction kit comes with five Veroboards and a detailed instruction book that tells you how to build an impedance matching module, an engine pulse counter, an audio amplifier and rf probe, a multivibrator and an audio oscillator. The projects don't require etching, wiring or terminals. The instruction book contains diagrams, schematics, illustrations and parts list. Theory and applications are also explained in detail. It's only $1.95. Write Walt O'Donnell, Vero Electronics, 48 Allen Blvd., Farmingdale, N.Y.

1966 Heathkit Catalog

We don't need to tell you much about the Heath catalog. All hams know about the excellent Heath amateur (and other) electronics equipment. The latest one is 108 pages with many of the pages in color and prices on many of the kits have been reduced, too. Among the new products listed in the catalog are the SB-110 6 meter SSB transceiver, the HA-14 SSB KW amplifier, the power supplies for this amplifier and lots of non-ham ones. Send for your copy today. Write the Heath Company, Benton Harbor, Michigan 49023. Please mention 73.

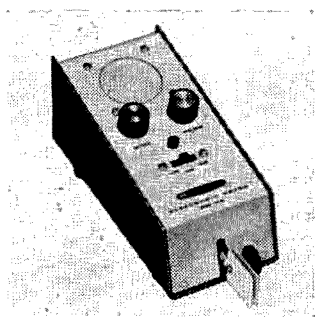


Hallicrafters SX-146

Hallicrafters new SX-146 receiver makes use of modern techniques to provide excellent amateur reception. It uses a single conversion signal path for minimum spurious responses and a 2.1 kc six section crystal lattice filter for optimum selectivity for SSB. There's also provision for AM and CW filters. It's designed for transceive operation with the HT-46 SSB transmitter, too. Sensitivity is less than .5 μv for 20 db S/N, drift is tiny, and the receiver is very attractive. The price is $269.95 and you can get complete specs from Bernard Golbus, Dept. 73, The Hallicrafters Co., 5th and Kostner Ave., Chicago, Ill. 60624.

Ami-Tron Fan Top Heat Sinks

Ami-Tron's newest product is a little fan top transistor heat sink for the popular TO-5 case transistors. It's black anodized for best heat dissipation. You can get a bag of three for only $1 from your local distributor or from WRL. Ami-Tron Associates, 12033 Otsego Street, North Hollywood, California.

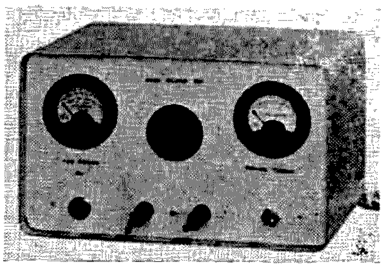


Heath HD-10 Electronic Keyer

Heath's new HD-10 all transistor electronic keyer offers about everything you could want in a keyer. It has no relays to stick since all the switching is solid state. The built-in paddle has sealed contacts. The dashes are the proper three dots long and the spaces one dot apart. The built-in oscillator and speaker with volume control lets you monitor on or off the air. It provides many other features too. Price is $39.95. For complete specs, write Heath Company, Benton Harbor, Michigan 49023.

TUCO Catalog

One of the best places to get transistors, ther semiconductors and subminiature parts Transistors Unlimited. They feature new, randed parts, pack them carefully, and ship iem fast. Their new large 16 page catalog in-ludes many pages of tremendous bargains iat will fascinate any ham. They also make number of power supplies, test equipment, nd interesting kits. You need this catalog. Vrite Elias Furst at TUCO, 462 Jericho 'urnpike, Mineola, L.I., N.Y. 11501.

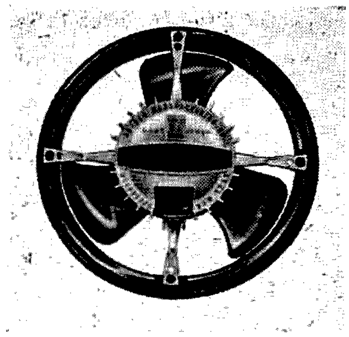


Quaker Diode Tester

The new Quaker solid state diode tester ccurately tests PIV up to 1000 PIV and leak-ge current up to 5 ma. You can quickly heck unmarked and odd lots of diodes, make ıre that diodes for series strings are up to pecs, etc. The unit is completely self con-ained with power supply, metering and con-rols in one attractively styled instrument ackage. It works on 115 vac. Price is $79.95. or custom models, or more information, write Quaker Electronics, P.O. Box 215, Hunlock Creek, Pa. 18621.

Amateur Radio Mobile Handbook

The new Sams Amateur Radio Mobile Handbook (AMH-1), by Charles Caringella W6NJV will be of interest to all hams who perate or are considering operating mobile. hapters are on converters and receivers, ansmitters, modulators, transceivers, trans-itters, receivers, microphones, antennas, ower supplies, control circuits and the sup-ression of transmission noise. Both commer-ial and home-brew equipment are discussed ı detail. On top of that, W6NJV is an ex-llent author and the book is very easy to ead and understand. It's well illustrated, too. ou can buy a copy from your local distribu-or if he's on the ball, or from Howard W. ams, 4300 W. 62nd Street, Indianapolis, ndiana 46206.

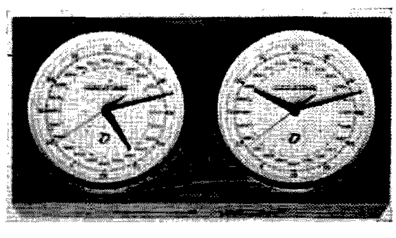


Rotron Skipper Fan

Rotron, a large manufacturer of fans and blowers for all electronic uses, has recently introduced an inexpensive fan, the Skipper, that delivers 100 cubic feet of air per minute. It mounts in a 4½" hole with no screws; a retaining ring holds it in place. It's quiet, too, yet usable up to 140°Fd. There are a number of accessories available, so get full information from Rotron, Woodstock, N.Y. 12498.

International Crystal Catalog

The new 60 page catalog from International Crystal Company is full of all sorts of equipment for the ham (and others). It lists all of the fine International crystals with complete operating data and suggested circuits, but that's just the start. They also have crystal ovens, plug-in transistor oscillators and cases, accessories, frequency meters, transistor and tube multivibrators, SSB filters, AOC transmitters and exciters, transistor subassemblies, converters, CB equipment, etc. Why procrastinate; send for one today. International Crystal Co., 18 North Lee Oklahoma City, Oklahoma 73102.



Quement Dual 24 Hour Clocks

You undoubtedly noticed page 73 in the December 73. You may have even noticed the beautiful set of two ten inch synchronous electric 24 hour clocks. They're mounted in a rich 12" x 24" x 2" wood cabinet and would enhance any room. Set one on your local time and one on universal time so you can both fill out your log and know when to eat. The set is only $24.95 FOB Quement Electronics, 1000 South Bascom, San Jose, California.

Howard S. Pyle
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Why Instruction Books?

Here's a subject which should be of pretty vital interest to you who are 'home-brew artists'; even more so if your projects result in building something which you, yourself have designed from scratch. Or, perhaps what you build has been taken from plans and specifications set down in a magazine or handbook article. We will wager that a few modifications and/or changes of your own will take place as you go, nevertheless. How are *you* going to know exactly what is what in a piece of gear which you build and which may give trouble (and often does) a few months later, unless you have an accurate black and white record on paper?

Suppose you are not a 'home-brew' artisan; you buy a piece of ham gear which has been designed, assembled and wired by a commercial factory. Invariably, if you buy it 'first hand,' a complete instruction book including schematics, voltage reading charts etc., is included. Unfortunately, when purchasing second hand or used gear, such instruction manuals are often missing. If your choice of a piece of equipment is in this category, stand pat on your refusal to purchase it unless the initial instruction manual accompanies it. Don't let the seller push you off with a casual statement such as ". . . oh, the dope and schematic is all in one of the surplus manuals . . ." or words to that effect. If the gear does happen to be a piece of surplus military equipment, make the seller show you in what surplus manual, even to the page, where the information exists.

Next, take the popular 'kit' type of equipment. Regardless of whether the item is but a simple transistor code practice oscillator or a more elaborate piece of gear such as a transmitter or a communication receiver, the factory always supplies a manual which, in addition to schematic wiring, mechanical assembly, adjustment and operation details, gives you every hint and tip essential to satisfactory operation of the equipment if you follow the printed instructions and illustrations.

Unfortunately the average ham designer-builder discounts the necessity for keeping a record of his home-built gear, simulating a factory handbook. This is just as true of the more experienced ham as with the novice. Probably this is due to the naturally human instinct to 'try it out' and right now, once it is built. If it works satisfactorily the normal procedure is to continue to use it as long as it holds together. Just let it 'blow up' once however and the long, tedious search for the trouble begins. ". . . Let's see; what size capacitors did I use here; what resistor there? What magazine or handbook did I take the parts list from? . . ." How much simpler, quicker and easier does such trouble shooting occur if you can refer to one simply bound or stapled set of instruction sheets and find all of the answers?

"So what?" you say. If you have actually constructed something, satisfy yourself that it really does work the way you had hoped that it would. Then, don't spend every minute of your leisure hours working it to death hoping that it will hold together. Give a few of those hours to a methodical recording of performance characteristics which will prove invaluable when a case of trouble, major or minor, develops (and it often does!).

Put together an instruction manual of your own to cover every complete piece of equipment which you build. Such a manual can even be written in pencil on ruled note paper of the school type; better if it can be typed and bound, either by stapling or in a ring binder of suitable size. While neatness is a virtue, the main element of any recording manual of this type is the information which it imparts. Suppose now that we examine what actually should constitute the essential information to cover a particular piece of 'home-brew' gear.

(1) An accurate schematic diagram of the item with appropriately labelled components which can be readily identified from an ac-

companying key nomenclature. For example, "VT-1" on the schematic to identify the oscillator tube in a transmitter; the key will show this as "VT-1; oscillator tube, 6V6 (or equivalent)." "R-1" on the schematic will appear as "R-1—7500 ohm carbon resistor" in the key list. Carry this through all of the components appearing in the schematic. In addition, show the *positive* (or in a few cases, the negative) potential which should normally appear at various terminals throughout the schematic. For example, where the positive plate voltage on "VT-2" may normally be 250 volts, designate it on the schematic as "VT-2: 250 v +."

(2) Actually, as in factory-prepared manuals for completely assembled and wired equipment, the schematic should appear as the last item in your book. The pages preceding the schematic should include brief paragraphs descriptive of the equipment as a whole, plus such tabulated tables as may be required to show the voltage readings to grounds (chassis in most cases) such as above mentioned as "VT-2: 250 V +." Any voltages which should read 'negative' normally, should be mentioned as well, otherwise it can be assumed that a positive voltage reading is applied against negative (chassis or 'ground').

(3) Last, but by no means least, particularly if the equipment which you have designed, assembled and built from scratch or from a magazine or handbook article, undergoes any modifications or changes while in usage, so indicate these changes on the schematic or by reference to the magazine or handbook article by month and page.

"Why" you say, "go to all this trouble to record such data; I built the thing, I know what makes it tick!" But suppose that you have ambitions for more elaborate equipment in the future? What you have already constructed and which has proven entirely satisfactory to you within its limitations, may constitute somewhat of a puzzling maze to a prospective purchaser on whom you hope to unload your 'brain child' in hopes of sufficient financial return to help out with the cost of the more elaborate gear which you contemplate building. If you can show such a prospective purchaser what your piece of gear is all about, by a methodical, written record, your chances of sale and of greater profit will be greatly enhanced. In addition, you will gain the respect of any such prospective purchaser who will naturally assume that anyone who goes to the extent of preparing a complete instruction and operating manual, has been just as conscientious in its construction; it will pay off, any way you look at it. . . . W7OE

Joseph Marshall WA4EP
Ozone, Tenn.

Improving the Noise Figure of Old Receivers

There are a number of commercial ham band or general coverage receivers and military surplus receivers which cover the 6 meter band. While some are hotter than others, practically none of these yield performance barefoot as good as that obtainable with a preamplifier or converter using a low noise rf tube. While a preamp is not too expensive, it is a nuisance when changing bands, and in many locations the additional gain is an embarrassment rather than an improvement because it intensifies the problem of overloading on strong signals. Actually, most of these receivers can provide close to optimum 6 meter performance with no changes other than a change in rf tubes.

The fact is that the cosmic noise level in the 6 meter band is high enough not to require an extravagantly low noise figure. The average equivalent noise figure of cosmic noise ranges from about 5 db to a high of about 8 db. This is achievable only in an extremely quiet location where no man-made noise is added to the cosmic noise. A receiver noise figure equal to the equivalent noise figure of the cosmic noise provides a practical optimum sensitivity. At this point, the maximum possible improvement in S/N ratio with a perfect receiver with no noise whatever, would be just 3 db; anything less than this total improvement yields an insignificant improvement in effective sensitivity. Thus a noise figure somewhere in the 4 to 8 db range yields practically optimum sensitivity in the 6 meter band. Most of the 6 meter receivers, however, have noise figures in the 12 db region, or higher. Fortunately, it is possible to lower the noise figure to the required optimum in most of them simply by changing the rf tube.

The old reliable 6AK5 is a still nearly ide 6 meter tube. It is capable of yielding nois figures as low as 3 db which is so far belo the cosmic noise that the difference betwee it and a receiver with no noise whatever woul provide an improvement of scarcely 1 db i S/N ratio. While it is not likely that a 3 d noise figure can be attained merely by sub stituting the 6AK5, it is possible with mo of these receivers to get the NF into the 4 t 8 db range.

In some cases, the 6AK5 can be substitute for the 6BA6, 6CB6, 6BZ6 or a similar remot cut-off rf pentode with no changes whateve In most cases it will be necessary to mak one small change at the socket terminals. I the 6AK5 the cathode is connected to bot pin 2 and pin 7, and the supressor is internall connected to pin 7. The other tubes mer tioned have the suppressor to pin 2 and th cathode to pin 7. Take a look at the wirin diagram of your receiver or, if you don't hav one, at the wiring at the socket of the rf tub If the suppressor is connected to the cathod by a wire from pin 2 to pin 7 no changes ar necessary. If both the supressor (pin 2) an the cathode (pin 7) are grounded (as in th SP600) you can also just plug in the 6AK with no changes.

In most cases, however, you will find th supressor (pin 2) grounded and the cathod (pin 7) with a cathode resistor. In this even you will have to unground pin 2. Usually snip of the wire with wire cutting pliers fror pin 2 to ground will do the job. In some case the socket lug is soldered to a ground tab o to the center shield on the socket. In this even you need to unsolder it so it hangs free. That' all.

Up in the air over RTTY?

If you want to go all out you can also remove the avc from the rf stage. The 6AK5 is a sharp cut-off tube and cuts-off very quickly with a small amount of avc. However, this is not necessary. It will provide peak performance on weak signals when you need it and the lower gain on strong signals is not necessarily a disadvantage. Now repeak the rf stage trimmers for peak noise with the antenna connected. Receivers having an antenna trimmer control make this very simple, though it would be well also to peak the tuned circuit in the plate circuit.

The improvement in noise figure and performance will depend on the tube line-up. In receivers using a single rf stage working into a 6BE6 mixer, the optimum noise figure cannot be obtained because the mixer noise makes too high a contribution to the overall noise. However, substituting a 6AK5 in an HQ170 or 110, for example, will lower the noise figure from more than 12 db to the 6 to 8 db region. If the receiver has two rf stages the improvement can be much greater. In my SP600-JX, for example, with a 6AK5 in the first rf stage and a 6BZ6 in the second, the measured (with a Marconi Noise Generator) noise figure is less than 3.5 db in the 6 meter band and less than 2 db in all the lower bands, and provides an effective sensitivity barefoot which cannot be improved with preselectors with noise figures as good as 1.5 db. For all practical purposes, it yields the best possible sensitivity attainable on the 6 meter band today.

An even greater improvement can be obtained with a 6AJ5. This tube is not well known and is expensive ($4 wholesale) when bought new. It was designed primarily for operation with 28 volts on the plate and screen in aircraft radar equipment, but with normal voltages it has a higher transconductance and draws more current than the 6AK5 and hence has an even lower noise figure. If you run into any surplus equipment using this little bottle, cannibalize it of these little gems. The procedure is the same as with the 6AK5, though undoubtedly better performance would be possible by juggling the parameters slightly.

Obsolete receivers using metal tubes can also be improved—and even more strikingly—but substituting the 717 for 6SK7's. The base situation is comparable to that involved with the miniatures. In the 717A the cathode is connected to pins 3 and 5 and the supressor is internally connected to pin 3. In the 6SK7 the supressor goes to pin 3 and the cathode to pin 5. Again if the supressor is grounded and resistor, it is necessary to unground pin 3 when substituting the 717A. Receivers having two rf stages with 6SK7's will usually deliver optimum performance with a 717A in the first rf stage and a 6AB7 in the second rf stage. The 717A is an octal based version of the 6AK5 and is available surplus for as little as 25c.

Still older receivers using top-cap type tubes present a problem. If you can find an 1851 you can use it in place of the original rf tube with minor changes at the socket.

There are several military versions of the 6AK5, namely: the 5591, 5608, 5654, 6096 and WE403B. Some are hotter than the regular 6AK5, but all are interchangeable. The 6AJ5 also occurs as the 7755.

In most cases this change of tubes will provide effective sensitivity as good as that possible with a nuvistor preamp at a fraction of the cost and with less danger of overloading effects. Your S-meter readings may be lower than originally and, of course, they will not be exaggerated as they are with a preamp. However, the ability to read weak signals, which is what counts, should be considerably improved. You can make a simple test to check the improvement or to see how close to optimum you are. With the avc off, listen to the noise with the antenna disconnected and then with it connected. The noise should increase markedly when the antenna is connected. The greater the difference the better the noise figure and therefore the better the effective sensitivity—up to a point. After you reach a 3 to 5 db increase in noise, the improvement in actual receiving ability becomes very slight, if any.

. . . WA4EPY

(W2NSD from page 4)

worrying about how radio waves were being sent out. He puzzled over it. If you transmit a hundred watts from a beam antenna, shouldn't there be some sort of reaction in the opposite direction? That's a good fraction of a horsepower and something should happen. Right? Wrong . . . he hung a beam from a string and it didn't move a hundredth of an inch. End of digression.

Now, back to those UFO's for a moment, One of the great puzzles about them has been how they can go several thousand miles per minute and then stop on a dime without squashing anyone inside. The Biefeld-Brown experiments have shown that everything within the field is acted on equally, so anyone inside a UFO would not experience the inertia of changes of speed or direction. This explains the right angle turns that have been witnessed many times.

The high voltages required to run the UFO's explain the bright violet light that they emit and the paralyzing effect they seem to have on nearby electrical systems . . . also the ozone smell they leave. Brown, after trying many shapes to find the most efficient for using the electro-gravitic force, ended up with one almost exactly the same as the bulk of the reported UFO's . . . and this was several years before UFO's became a common newspaper item.

It would seem to me that we radio amateurs are in a beautiful position to break the barriers into this new field, just as the amateurs of the past broke into radio. Many of us have a technical enough background to start experimenting and we don't have the pressure of having to succeed, as do the commercial boys. Thousands of us can devote years to something like this . . . and eventually one of us is going to hit. And what a jackpot that will be! It is beyond the imagination. The chap who gets the first patent on an electro-gravitic receiver could possibly parlay that into something bigger than RCA. Who knows, the solution to our spectrum problems may be just ahead, waiting for some hams to get to work on them.

A parting hint for those of you who might like to try . . . the electro-gravitic force varies according to the dielectric constant (K) of the condenser, the distance between the plates, the area of the plates, the voltage used, and the mass of the dielectric used.

Many will ask, if the UFO's are real, how come the government is not admitting it? Simple, really. We have intruders in our skies and landing in our country and our military doesn't know what to do about it. We are darned sure that they are trying to learn everything they can about the UFO's in the hope that they will eventually come up with some sort of answer to them . . . some way to protect ourselves from them. Until that time they feel that the best policy is to keep quiet about what they do know on the basis that the beings in the UFO's can monitor our radio and television and that whatever is broadcast about UFO's will be picked up, letting them know what we know or don't know. This makes sense.

Our Air Force has the unhappy job of trying to cover up things as best they can. They try to keep people quiet, keep things out of the news, discredit sightings, etc.

Needless to say, this is something that you should not discuss over the air. While I expect that the UFOites are probably not listening to our ham bands . . . I have trouble listening to them for any length of time now and then, still, why take chances.

OK, so I'm a nut . . . this year. Let's see how nutty this all sounds five years from now.

American Morse

Morse telegraphers may be interested in the Morse Telegraphy Club and should drop a note to Ralph Graham W4RJX, 6443 Dryden Drive, McLean, Virginia 22101. They have a bi-monthly publication of interest.

Books

We're starting preparation for a series of small books to run as inserts in future issues of 73, books of 15 to 30 pages in length covering special aspects of amateur radio. Perhaps you have some ideas for a book that we might be able to publish. If you are interested in preparing something like this then drop us a note telling us what you propose. We'll pay up to $500 for a 15 pager and up to $1000 for a 30 page book, depending on the interest and the quality of the manuscript. Would you prefer that in 10's or 20's?

Help wanted

We're still looking for the right man for advertising manager of 73. This calls for someone with a good background in selling, someone who is already doing well. We'll pay a basic salary of $7500 plus 10% on any increase in our advertising income. This means that if you bring our sales up to those of QST you'll be making about $27,500! You can live

like an earl up here on half of that. If you *know* you can step in and handle the job and it sounds attractive, all you have to do is tackle your first big selling job: sell me.

We're also looking for two sincere and experienced hams to spend the summer with us. The work will primarily consist of improving the VHF installation on 73 Mountain and installing a remote control system so it can be operated from home base during the winter. We'd like to put in FM, TV, RTTY, and stuff like that too. Pay will depend somewhat on experience, but will be scanty. You will have a ball though and get in a lot of hamming (on your own time, please). See if you can convince me that I really need you for this. I'm looking for doers, not talkers. Tell me what you have done, not what you'd like to do.

Need Vermont?

The Vermont QSO party is Feb. 19-21. Full info can be had from K1MPN, 3 Hillcrest Drive, Montpelier, Vt. 05601, but look for those rare ones on 3685, 3855, 3909, 7030, 7240, 7290, 14040, 14225, 14290, 21050, 21300, etc.

Scoundrel

The other night, while eavesdropping on the low end of 75 (as the cliché goes), I didn't hear any good of myself. One fellow mentioned how great 73 is and how he thinks it is better than QST. . . . I liked that. Then another said that he wouldn't read that filthy rag for anything, why that Green was one of the lowest opportunists in the country . . . look what happened to him, he printed an attack on the Navy in CQ and had to print a retraction the next month and was fired, and it is well known that he doesn't pay for articles for 73. There was this poor fellow who came all the way from Germany to work for 73 and was fired after just one week and thrown out penniless and they kept half of his belongings which arrived later. Besides that he takes advantage of every little thing that goes on to work up amateurs against the ARRL, usually lying and exaggerating to do it. The fellow sounded like a combination of the hate rantings put out by the Anti-Communist Amateur Radio Network and the Washington Amateur Radio News.

Never one to keep my peace when provoked, I called in and asked if they were interested in a little clarification. They were.

I explained that the Navy article was published in the February 1957 issue of CQ. I

was out at the Fresno DX Convention when I received my airmail copy of the issue and it was there that I discovered that my assistant had "beefed up" the article, as he explained it later, so it would have more impact. Well it certainly had impact. I flew to Washington and explained to Admiral Bruton what had happened and we printed an apology the next month. In 1958 the Admiral (then F7FA) and I had a good laugh over the incident when he came to a party thrown for me in Paris. The article did create quite a disturbance and many believe it had something to do with the complete change in Navy policy on ham radio which followed shortly. Until the article only one Naval ship had ever been permitted to use amateur radio . . . afterwards hundreds were authorized. Now you hear them in all parts of the world boosting the morale of the operators and their shipmates.

I left CQ three years later and non-payment of authors was an important contributing factor. When I decided to start 73 I made it a firm policy that all articles in 73 would be paid for and promptly. They have been. I pay for all articles in 73 when I accept them and this can be up to a year before they get into print. At CQ the published policy was to pay for the articles when they were published, but I found that it often took from one to three years for an author to get paid for his article and there seemed no excuse for this when we were making a profit in six figures and the publisher was able to retire and loaf on an enormous yacht. I got so furious at that and other things like it that I got fired. My policy of paying fast and well for articles has resulted in 73 getting first choice on almost everything written in our field, which explains why 73 has the new developments months before they reach the other magazines . . . and why all of the top writers in our field write for 73.

Now, about that chap from Germany. Yep, we had one. He was getting discharged from the Army and wanted to work for 73. I told him we would give him a chance to show what he could do. Apparently the Army taught him a lot of interesting things on how to avoid work and he sure didn't get on with our small hard working staff. After a couple of months he left one night with no notice, leaving behind only a TV set with more payments due on it than it was worth. Pierre, F2BO, who roomed with him, kept up the payments for him for a few weeks until it was obvious that we were not going to hear from him and the set was turned back to the store.

Every now and then I hear that I've been lying about the ARRL, but no one is ever explicit about what I've said that is a lie. Just recently John Huntoon wrote a letter to the chairman of the National Convention Committee demanding that 73 not be permitted to exhibit. He threatened removal of ARRL support if 73 was permitted to exhibit. In this letter he lists 28 instances where he claims that I have lied in my editorials. At long last I had something definite to work with. I read over the list of my lies with growing wonder. I read them all a second time. This was incredible! Not one single one of those 28 instances was in any way other than completely false. I sat down to my typewriter and wrote an answer to each and every one of Huntoon's charges of lies and sent this formidable document to the National Committee Chairman, asking that 73 be permitted to exhibit since the basis for demanding that we not exhibit was entirely false. Then, figuring that others might be interested in this whole thing, I put it together into a booklet . . . 24 pages. You can see why I don't try to print it all here. Imagine taking 24 pages of the magazine for something like this? Anyone who is interested in the real facts and an expose of stupidity, ARRL lying, and distortion is welcome to send a stamped envelope for a copy of this reprint. Put 8¢ on the envelope, it is heavy.

As far as me being an opportunist . . . hmmm. I try to call 'em as I see 'em and I refuse to sit here and shut up when someone or some group is doing something lousy for ham radio.

$5 Reward

While most of the radio parts distributors around the country do carry 73 on their counters, there are a few that have either not gotten the word or else have resisted our not too energetic approaches. Now, if you'd like a little extra money in the mail all you have to do is scout around and find a parts distributor who should have 73 on his counter (but doesn't), talk him into making out a purchase order for ten or more copies a month, and send us the order. We'll send you a check for $5.

If the distributor gives you any static about handling 73 just point out that 73 is the fastest growing ham magazine in the world, that it runs 25-35 feature articles every month, and that the cover price is 50¢ and all he has to pay for copies sold is 30¢, and nothing whatever for copies not sold. Can there be a

better deal than that? Nothing to lose in any case, and 73 is an excellent drawing card for his store. For some reason I am completely at a loss to explain fellows will drive miles looking for a copy of 73 every month, but they somehow don't get around to subscribing. It's weird, but it does bring traffic into radio stores, so why fight ham nature?

W2NSD joins ARRL's SS troops

I've been trying to remember back to just how this whole harrowing thing started and I don't remember. I get such laughing fits when I read QST that I know it couldn't have been anything in there that did it . . . but somehow, for the first time in several years, I found myself sitting there operating in the Sweepstakes Contest.

Along about Thursday I got to brooding over it and on some subconscious level must have thought that I would give it a try. I think I expected to give up after meeting with frustration as I have in the last few VHF contests. I remember the last CQ VHF contest I tried. By the end of about three hours I found only about three chaps making any effort to have a go at it. What possible fun is it to beat three fellows?

On Friday I galvanized into action and spent a good deal of the day bumbling about the yard trying to put up a simple stupid dipole for 80 meters so I would at least be on two bands for the damned contest. I figured my twenty meter three element beam would handle that band OK, but I had to have some place to operate when 20 closed for the evenings.

I used to throw dipoles up in the trees and work out all over the world. This time I decided to put up a sagging dipole . . . known as an inverted vee, with the center tied to the 70 foot tower. Several hours later I dragged myself back in the house to rest my weary legs (I had to climb the bottom 30 foot section several times), my weary arms (have you ever cranked one of those towers down and back up again?), and nursed the big gash in my head which I sustained at the 50 foot level when I climbed into a tower lock without looking. I cranked the tower down because I was afraid to climb that skinny little top section which was flapping around up there.

What was left of me collapsed into the chair by the rig and I eagerly tuned up on 80 to see what my new antenna would do. What it did was not tune up. Oi. After a bit of checking I found that it resonated nicely

about 4500 kc. I should have cut a new one instead of digging out that mess coiled up in the barn and spending all day getting it up. It didn't take long, once I managed to get back on my feet again, to dangle some extra wires from the ends and bring it down to the band.

Saturday morning I made up some log sheets, laid in a stock of hamburger and Metrical, unplugged the phone, and took a quick look at the rules. After taking care of my days' mail and chatting about an hour on twenty with friends in Europe I grabbed for a couple hours sleep so I would be fresh for the contest. I think I spent most of the sleeping time thinking about the contest.

It seems that we can operate for any 24 hours of the 30 hour contest period. I decided to get some sleep Sunday morning from 4-8, which is usually the slackest period of a contest, plus a half hour Saturday night so I could watch "Get Smart" on tv and an hour Sunday night to watch Perry Mason. No use missing those shows if I don't have to. I don't watch anything else except Dick Van Dyke, so missing them would louse up two thirds of my weekly watching. On the other hand I have managed to miss all of them many times with no noticeable ill effects other than a slight increase in the sourness of my disposition.

Let's see, twenty-four hours at sixty minutes per hour is 1440 minutes for the contest. If I can make one contact per minute I can make almost 1500 QSO's. Then I got to brooding over that incredibly ridiculous message that ARRL says we have to exchange. This includes such important information as the year of my first amateur license and my birthday and month. Good grief! I timed a transmission of the whole message . . . hmmm, twenty seconds if I give it fast, and chances are that many ops will ask for a repeat of parts if it doesn't come rather slowly. Allowing time for establishing a contact, I could see that one per minute would only be possible with expert ops.

More of my resting time was spent in grumbling to myself over this crumby situation. The object of the contest seems to be to make as many contacts in as many ARRL sections in a given period of time as possible. So why the molasses? Why not exchange calls and sections and let it go at that? The SS used to be simpler. I remember the first one I tried back in 1941. The little bronze medal I won that year is still around. The next contest wasn't until after the war, in 1946. I won this one for my section also. The contest was

rugged then, running for 66 hours over two weekends with 40 hours of operating permitted.

My mind went back to 1951 when I operated the first weekend at W2NSD/8 out in Ohio, where I was working. During the next few days my new call came and, while visiting New York the next weekend, I operated from there as W8NSD/2. The scores for both weekends were formidable, but not enough to win in those hotly contested sections.

The flag dropped at 4 pm and I charged into the QRM on twenty. Friend, you have never heard anything like that in your life. I tuned from one end of twenty to the other looking for the slightest crack in the barrage of signals to slip myself into. There wasn' any place at all. The signals were every hundred cycles right on through the band and who knows how deep? They were all very loud. It was even worse than the mess 1S9WNV made out of the band when he turned up on Spratly Island for a couple days and the DX boys knew they had to work him or forever lose their position on the DX lists.

Sam, W1FZJ, has always said that the way to do well in the SS contest is to have such a strong signal that everyone comes to you. In the past I had always had to fight for every contact, jumping around the band and waiting for other fellows to finish their contacts so I could exchange with them. This time, once I got started, I found that my signal was commanding enough so that I never had to move . . . for hours at a time and that indeed everyone did come to me. Many times when I finished with one station there would be five or ten calling me at once on the frequency. Boy, could I have worked a lot of stations if I hadn't had to go through those long complicated exchanges.

Though I knew that I had a fair signal on twenty, I wasn't sure it was good enough to stand out the way it apparently did. And I had no idea of how I would do on 75. I had figured that I would get my sections on 20 and my contacts on 75. It worked out the other way around. Alaska, Hawaii and Canal Zone all called me on 75! Plus I worked most of the sections down there, with very few exclusively on twenty. My contacts were split about 50/50 though.

A study of last year's results showed that the top man had made 733 contacts. Perhaps you can understand my enthusiasm when I passed that figure with three hours left to go. As the end neared I reached 850 contacts and decided to stop there even though I had some time left and there were still stations

calling me. Though I didn't hear anyone with a score anywhere near that high, I suppose there are some chaps that will beat me out for the top honors. As I say, I didn't tune much. It is quite possible that the other top men did as I did and we may never have even worked each other.

In retrospect I don't think I could do a lot better than I did. I did waste some of those 1440 minutes, I admit. Things like going to the bathroom, frying a quick hamburger, letting the dog in and out a dozen times or so, short stretches, shooing away visitors, changing bands, new fuses, etc.

Though I never sought sections, letting them come to me, I did end up with 73 of them. Only VE6 and VE8 never came to me . . . drat. It would have been nice to have worked all sections too.

Does it help to be well known? Not really, for though every now and then someone would say hello Wayne to me, it frequently was followed by several precious seconds of compliments on the magazine . . . which I hastily agree are not at all unwelcome under normal circumstances . . . and requests that I keep up my fight for what I believe is right.

The factor that will probably put many stations ahead of me is the power multiplier. We all used to laugh every year when the SS results were published and there were all those pp-100TH rigs being run at 90 watts input. This wasn't so funny back in 1947 when I made a determined effort to do well and ended up with one of the top scores, only to find myself down to about fourth place in the country after application of the low power multiplier. The chap that won was putting in a signal that was stronger than a well known ham near him who runs 5 kw and a rhombic. I shudder to think what he was using for an amplifier. The power multiplier makes embarrassed liars out of most winners . . . but if they don't lie about the power they don't win and it is that simple. I do not believe that there is any way to run up a high score without using high power.

Except for a monumental case of writers' cramp (34 pages of logs) and a loss of ability to focus my eyes which was probably brought on by a slight stroke when someone tried to get my frequency away from me . . . an affliction which has since cleared up, as did my frequency when I called CQ contest for three minutes. . . . I managed to survive the ordeal fairly well. I'm not sure, I may even have had fun.

. . . Wayne

Why slave for that wallpaper?

Buy these certificates to dress up your shack. Be proud of the effort it took to earn the money to be able to afford them.

The CHC Certificate

The Certificate Haters Certificate is available to any ham with $1 who submits a signed statement that he has never been awarded any other certificates and that he will hate any that he happens to get in the future.

The WAAS Certificate

The Worked Almost All States Certificate is available to hams who have proof of contact with 49 states. It takes almost as much effort to work 49 as 50. Why should this work go unrewarded? Send the 49 QSL's in statabetical order or a statement signed by two responsible radio club officials that they've seen the 49, along with a note of the missing state. Mode stickers for CW, AM, SSB, RTTY, band stickers and stickers for all contacts made within one year are available for $1 extra for each sticker.

The DXDC Certificate

Everyone knows that this matter of "countries" is ridiculous. The DX Decade Certificate requires contacts with ten countries (defined as members of the UN; too bad, Switzerland, Communist China, etc.). Same regulations and endorsements as the WAAS Certificate above. There are no stickers for more than ten countries.

Countries for DXDC. Members of UN.

Afghanistan
Albania
Algeria
Argentina
Australia
Austria
Belgium
Bolivia
Brazil
Bulgaria
Burma
Burundi
Byelorussian S.S.R.
Cambodia
Cameroon
Canada
Central African Rep.
Ceylon
Chad
Chile
China
Colombia
Congo (Brazzaville)
Congo (Leopoldville)
Costa Rica
Cuba
Cyprus
Czechoslovakia
Dahomey
Denmark
Dominican Rep.
Ecuador
El Salvador
Ethiopia
Finland
France
Gabon
Ghana
Greece
Guatemala
Guinea
Haiti
Honduras
Hungary
Iceland
India
Indonesia
Iran
Iraq
Iceland
Israel
Italy
Ivory Coast
Jamaica
Japan
Jordan
Kenya
Kuwait
Laos
Lebanon
Liberia
Libya
Luxembourg
Malagasy Rep.
Malaysia
Mali
Mauritania
Mexico
Mongolia
Morocco
Nepal
Netherlands
New Zealand
Nicaragua
Niger
Nigeria
Norway
Pakistan
Panama
Paraguay
Peru
Philippines
Poland
Portugal
Rumania
Rwanda
Saudi Arabia
Senegal
Sierra Leone
Somalia
South Africa
Spain
Sudan
Sweden
Syria
Tanganyika and Zanzibar, United Republic of
Thailand
Togo
Trinidad and Tobago
Tunisia
Turkey
Uganda
Ukrainian S.S.R.
U.S.S.R.
United Arab Republic
United Kingdom
United States
Upper Volta
Uruguay
Venezuela
Yemen
Yugoslavia

The RRCC Certificate

If you're a Real Rag Chewer, you can keep it going for at least six hours. This certificate is for hams who have had a single two station contact going for six hours with no interruptions. Include signed statement to that effect.

Each certificate application must include $1 to help cover the costs of administering the program, etc.

73 Magazine Peterborough, N.H. 03458

Caveat Emptor?

★ Price—$2 per 25 words for non-commercial ads; $5 per 25 words for business ventures. No display ads or agency discount. Include your check with order.

★ Type copy. Phrase and punctuate exactly as you wish it to appear. No all-capital ads.

★ We will be the judge of suitability of ads. Our responsibility for errors extends only to printing a correct ad in a later issue.

★ For $1 extra we can maintain a reply box for you.

★ We cannot check into each advertiser, so Caveat Emptor . . .

TOOOOBES, TRANSMITTING-SPECIAL PURPOSE. New boxed, guaranteed . . . 6CW4-$1.40, 6146-$2.55, 417A-$3.95, 826-$6.00, 6360-$3.45 . . . Free catalog . . . Vanbar dist, Box 444X, Stirling, N.J. 07980.

PRINTED CIRCUIT materials. Three sample pieces and details. One dollar. Betty Lou Nolin, 35 Arbor Drive, New Hartford, N.Y. 13413.

ART'S QSL'S Samples 10¢. Art Bliss, 1829 N. Catalina St., Burbank, California.

CONVERTERS $10 and up. World's largest selection of frequencies. Ham TV vidicon cameras and parts at low factory-direct prices. See them all now in our full page ad in this issue. Vanguard Labs, 196-23 Jamaica Ave., Hollis, N.Y. 11423.

GIANT 20th ANNIVERSARY CATALOG. Increase your product category. TV cameras, electronic equipment, kits, Hi-Fi, components. Free copy. Denson Electronics, Rockville, Conn.

TELETYPE TEST SET I-193C. Government rebuilt, still crated. Tests RTTY transmitters, converters, relays. $14.95 each, two for $27.40. F. O. B. Harrisburg, Pa. Satisfaction guaranteed. Telemethods International, 3075 E. 123rd Street, Cleveland, Ohio

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IT'S SUPERCALIFRAGILISTICEXPIALIDOCIOUS! Free new catalog of etched circuit boards, radio books and information on Kit-of-the Month Club. Leader Enterprises, Box 44718-KH, Los Angeles, Calif. 90044.

WE WILL PAY CASH: Wanted, popular, late model unmodified amateur equipment. Highest prices paid for clean, good operating gear. Write Graham Radio, Dept. 10, Reading, Massachusetts.

CLOSEOUT discontinued full size beam, new ⅞" and 1" aluminum. Three element 20 meter, $22, Two elements, $16. Three elements on 15 meters, $16, two elements, $12. Express collect shipment. Gotham, 1805 Purdy, Dept. 73, Miami Beach, Fla.

ARE YOU SINCERE? Are you *really* looking for the best deal on a new or fully guaranteed used unit? Let us convince you with a specific quote that will *really* save you money. Graham Radio, Dept. 10, Reading, Massachusetts.

ːLOBAL WRIST WATCHES. Feature 24 hour world ime conversion. Free brochure. Mention 73. Nordlund. 635 West Irving Park, Chicago, Illinois 60634.

'UNAVERTERS! Transistor 6-1 tuning calibrated con-erters for AM-CW-SSB! Half a mobile station $19.95-24.95! Sensitive, selective, tunable BFO! Marine, ama-eur, SW bands! Herbert Salch and Co., Woodsboro, 'exas.

IEATH MARAUDER, Hallicrafters SX-111. Both for 450 or will sell separately. J. Michlin WA2WPN, 2282 ironx Park East, New York, N.Y. 10467.

ıLTERNATOR UNITS Leece Neville 100 amp, 14 v nd 7 v. $55 each. K6PDR, 26107 Delos Drive, Tor-ance, California. Phone day 679-8711 ex 22716, night 26-2711.

IODEL 15 complete with table. Alltronics TU model I, Kleinschmidt typing reperforator model AN/GGC-3. ːlCPX, 617-862-2448, Lexington, Mass.

'ICTORIAL STUDY in electrical theory and basic adio communication for the amateur. Understanding hrough visualization. Free details. Dwight Cross, 212A Lynch Street, St. Louis, Mo. 63118.

ıOUTHERN COUNTIES ARA (N.J.) will hold its an-ıual installation dinner on Friday evening, January 4 at Copsey's Restaurant on the White Horse Pike, ıbsecon, N.J. All hams, wives and those interested in mateur radio are welcome to attend. Details from ː2SOX, 2217 Cornwall Ave., Northfield, N.J.

ːSTATE SALE: Reasonable offers. SX-100, HT-40, ːX-140, Twoer and AC/DC supply, HB 2 m transmitter nd receiver, precise model 300 scope, Eico model 66 tube tester, BC-221T frequency meter and RT-8/ARC-1. Contact Mrs. R. L. (Sue) McDougal, 1690 ːountry Club Drive, Marion, Iowa 52302.

00 2C39's and 3CX100A5's. Pull outs and unchecked. 'rade all or part for hamgear. You name it. Jack D. ıines, Box 5325, Dallas, Texas.

ːALAXY V, DC power, VOX, calibrator, 20 and 40 vhips and bumper mount, 2 quickoffs, mic, cables and peaker. Cost me $599. Best reasonable offer. G. Slaw, 4 Meigs Ct., Bensenville, Illinois.

ıIRSTREAM 18' Globetrotter. Perfect self-cont. No .ents. $2500. Nathan D. Vance K8TMX, 823 Cory St., 'ostoria, Ohio.

ːOLLINS 75A3-32V3 both $325.00. AF-67 and PMR6A eceiver and power supplies. All for $65.00. Plate ransformers, 1 ampere, 3200 volts center tap. $40.00. ıaury Blog W2RBZ, 25 Peru Street, Metuchen, N.J.

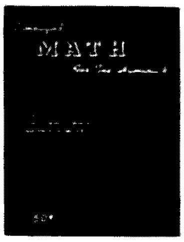
ːLEGG ZEUS and 11 element 6 meter beam. Contact VB2CUD, 201-756-8340.

ːECHNICAL MANUALS. Signal Corp. Some of the .vailable manuals R-390,A, SP-600, BC-610, I-177, ːV-7, teletype manuals, test equipment. World's larg-st list 10¢. Quaker Electronics, Hunlock Creek, Pa.

ːWAN 350 and 117C supply. Less than six months old, ıew condition. $385.00. Stu Kelly K3MAK, Fox Hill ːoad, Perry Hall, Md. 21128.

73 Books

RECEIVERS. K5JKX.—If you want to build a receiver or to really understand your receiver, this is the book for you. It covers every aspect of receiving in author Kyles usual thorough manner. **$2.00**

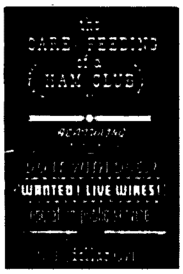


SIMPLIFIED MATH FOR THE HAMSHACK —K8LFI.—This is the simplest and easiest to fathom explanation of Ohm's Law, squares, roots, powers, frequency/meters, logs, slide rules, etc. If our schools ever got wind of this amazing method of understanding basic math our kids would have a lot less trouble. **50¢**

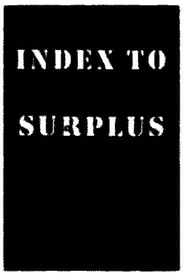
CW—W6SFM.—Anyone can learn the code. This book, by an expert, lays in a good foundation for later high speed CW ability. **50¢**

FREQUENCY MEASURING—WØHKF—Ever want to set yourself up to measure frequency right down to the gnat's eyebrow? An expert lets you in on all the secrets. Join Bob high up on the list of Frequency Measuring Test winners. **$1.00**

CARE AND FEEDING OF HAM CLUBS—K9AMD.—Carole did a thorough research job on over a hundred ham clubs to find out what aspects went to make them successful and what seemed to lead to their demise. This book tells all and will be invaluable to all club officers or anyone interested in forming a successful ham club. **$1.00**



ATV ANTHOLOGY. WØKYQ and WA4HWH.—A collection of the construction and technical articles from the ATV Experimenter. Includes a complete, easy to build vidicon camera and 50 other projects. The only book available about ham TV. **$3.00**



REVISED INDEX TO SURPLUS—W4WKM.—This is a complete list of every article ever published on the conversion of surplus equipment. Gives a brief rundown on the article and source. Complete to date. **$1.50**

TEST EQUIPMENT HANDBOOK. W6VAT.—Every ham needs to have and know how to use test equipment. This book tells you how to make valuable ham test gear easily and cheaply. It also covers the use of test equipment. **50¢**

73 Magazine
Peterborough, N.H. 03458

HALLICRAFTERS HT-30 sideband transmitter like HT-32 only smaller. Excellent stability and suppression. Manual. $145. C. MacDowell W7UB, 2455 SW Montgomery, Portland, Oregon.

SWAN 240 and HP-10 dc supply, real good shape; best offer over $225. Les Grinspoon W3BDE, 12317 Village Square Terrace, Rockville Terrace, Rockville, Maryland 20852. 949-3159.

PAIR 4CX250B tubes and Eimac special sockets, all brand new $50. VE6AKU Glenn Christopherson, Innisfail, Alberta, Canada.

ART-13, good shape $25.95 without two 811's and one 813, or $35.95 with all tubes. You pay shipping. WN5MBU, Box 381, Hobbs, New Mexico.

QSLS BROWNIE-W3CJI, Highest quality since 1939. Samples 10¢, with cut catalog 25¢. 3111R Lehigh Street, Allentown, Pa. 18103.

KNIGHT STAR ROAMER. Factory aligned/calibrated. Excellent for beginner, SWL. Like new. $25 ppd. continental USA. David Brender, 300 Bronx Park East, Bronx, N.Y. 10467.

SELL OR SWAP: Ameco CN50, used Cleveland electronics course. Want ham transmitter, mint BC-312, SSB mike. Make offer. W8FWB, Box 242, Dover, Ohio.

NEW RG-8 COAX. 100 feet with PL259 each end, $8.25. 750 ma diodes: 600 piv 30¢, 900 piv 55¢. Send for flyer. Don Marquardt K9SOA, RR7, Box 436, Crown Point, Indiana 46307.

DRAKE TR-3, RV-3 and AC power supply, $550. Hallicrafters HA-2, HA-6 and AC power supply, $250. Absolute finest mint condition. K4TCK, 689 Beth Lane, Lexington, Kentucky.

TRADE YAMAHA 80 cc cycle for RTTY gear or cash. I had a back operation and cannot ride. 1963 model with helmet, extra sturdy baskets. Excellent condition, only 1700 miles. I need printer, keyboard, tape punch/reader. Will transport 200 miles. Carl Dudey K9WWQ, 45 N. Orchard, Madison, Wisconsin.

QRM FILTER-3 kc bandpass filter works with any 500 ohm receiver audio output. Unused surplus 25 watt UTC, 2 for $5. Tone filters for TTY or signalling: 595 cy, 765 cy, 2635 cy-2 for $5.

Generator noise filters, aircraft grade 25 amp, 50 amp $1 each. Lock City Electronics, Box O, Freeland, Michigan.

75A1, mechanical filter, matching speaker—$175. Classy 80-20 meter 100 watt phasing rig, $75. 10% off for pick-up. Fred Nichols, 1119 Howard, Niles, Michigan 49120.

HEATH SIXER, usual modifications. Good condition. Two six meter crystals included. $40 or best offer ppd. WB2QJA, 116-02 221 St., Cambria Hts., N.Y. 11411.

GOT BIGGER RIG, sell Knight T-60 for $35. Bill Herrmann, Oakcrest Acres, Rte. 1, Springfield, Illinois.

LAFAYETTE HE45B, 6m-Xcvr, VFO-HE6la, unused-mint, $102. Ameco TX-86 factory wired, 80-6m, AS-3 power supply, V.G., $105, WB2JJX, 36 Brompton Rd., Garden City, N.Y.

POWERFUL NEW 572B's—2000 hour guarantee—never unboxed—$39.50 matched set of 4 postpaid. Need Drake DC-3 Len Malone, WA5DAJ Box 1222 Garland, Texas.

CHANGE CRYSTAL FREQUENCY—even plated type. Deluxe Kit includes ammonium bi-fluoride, holders, storage and etching vials, complete instructions. Only $2.00, Postpaid.—Ham-Kits, 16 West End Court, Long Branch, N.J.

SELL DRAKE TR-3 $449 SW-240 with matching PS/Spkr. $275. Both excellent, look new, used very little. Bill Porter, W5FAH, Kenedy, Texas 512-FR52505

TH3MK2 BEAM—Hy-gain's finest, most popular 3 element tribander—can't use—never unpacked—Prepaid U. S. A. $69.95—WE6KEH, 781 California, San Luis Obispo, Calif. 93401

QUITTING will sell one: oscilloscope EICO 430, $45; dynamic conductance tube tester EICO 667-k $65; deluxe signal generator EICO 315, $40; audio generator Heathkit AG-8 $15; resistance capacitance bridge EICO 950B $15; capacitor tester EICO 955K $13; VTVM Conar 211 $18; decade condensor Heathkit IN-21 $10; decade resistor $4; Coyne radio and TV encyclopedia set $15. Francis Jacobs, 1111 Vattier, Manhattan, Kansas

NEED RESISTORS? Brand new, FAMOUS NAME, ½ watt 10% standard carbon. Any regular 10% value from 10 ohms to 2.7 megohms $.05 each postpaid. Any quantity assorted. Pick your own values. Rapid shipment. Minimum order $1.00 TEPCO, Box 508, Tullahoma, Tenn. 37388

EL 37 BRITISH DX transmitter wanted in good condition. Write 3 Vendue Range, Charleston, S.C.

WANTED: Pre-1934 QSTs. Also binders for both new and old volumes. Also 73 from first issue to Dec. 1964. Also CQ from first issue to Dec. 1964. Any good run acceptable. Will pay cash. Must be in good condition! R. Kampf 9 Black Birch Lane, Scarsdale, N.Y. 914-723-1467.

COUPON BOOK—Special offers from various firms for members of electronic Experimenters' Club. Dues $2.00 or write for further particulars. Box 5332-EA, Inglewood, Calif., 90310.

600 PIV @ 750 MA Tophats—10 for $2.50. Tubes—pullouts—4CX1000 $37.50, 6146 or 6883 $1.25. 4CX250B—$6.50, 4-125—$5.00, 5894A—$5.00, 813—$5.00, 5763 or 6CL6—$1.00, 4X150—$4.50, 12AX7-12AT7-12AU7-6AK5-6BH6-6C4-6CB6-6AK6-6S4-6AQ5-6BJ6-6AL5 — 4 for $1.00. FRR rec. (4—8MC drawer) $75.00. All material guaranteed. East Coast Electronics 123 St. Boniface Rd. Buffalo, N. Y. 14225. Min. order $2.50. Include sufficient postage. Canadian money accepted at par.

SPECIAL!! $50.00 credit on the purchase of station accessories when you order a NEW Galaxy V or SB-34. Cash or time payment. RECONDITIONED SPECIALS: DX-40 $29.95, HQ-100C w/m Speaker $89.95, Galaxy 300 $188.00. Order To-Day. ELECTRONICS SALES, EXECUTIVE HOUSE #15, LEWISBURG, TENNESSEE

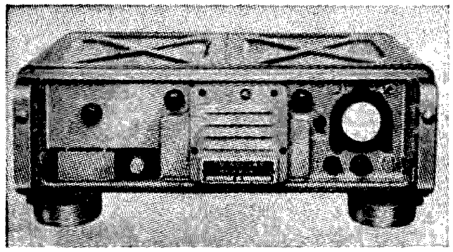
ART-13 fully converted 10-80, cool 300-w FONE-CW, w/110v ac pwr sup-all over-rated components; 75A-2 gud condx-$250 complete station. Xfrmr 3000/1700-0-1700/3000 vac about 1 amp $15.00 cash/carry. Clean-as-a-pin 15-type printer w/converter & 3-inch scope in 1 unit $175.00. W5ENH, 2608 S. Taylor, Little Rock, Ark.

TAPE RECORDING: Need someone with facilities to reproduce prepared 3¾ ips tapes in limited quantities. Good speech quality required. Original tape and supplies furnished. Write IoAR, Springdale, Utah 84767.

R U REALLY interested in Ham Radio? Send SASE for IoAR information and help fight Amateur Radio Apathy. W7ZC, Springdale, Utah 84767.

75A4 Collins Rec. excellent cond. serial #085—2 filters, 3 & 6Kc, speaker & vernier dial $350.00. WA9DFH 5631 W. Morris St., Indianapolis, Indiana

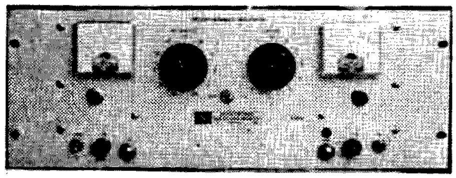
DAYTON HAMVENTION April 16, 1966—Everyone welcome at the Dayton Amateur Radio Association's 15th annual Hamvention, Wampler's Ballarena, Dayton, Ohio. Watch Caveat Emptor for information.



CV-60/URR (URA-8) FREQ. SHIFT CONV.

The model everyone is looking for. We have half a dozen, made by **RCA** in new condition. Audio type feeds from 600 ohm output of your receiver.

$150.00



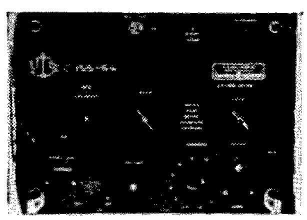
PROGRAMMABLE E/M POWER SUPPLY

Regulated Electronic Measurements Power Supplies. In excellent condition.

#231AM	0-300 volt 100 ma	**40.00**
#232AM	0-300 volt 200 ma	**45.00**
#233AM	0-300 volt 300 ma	**50.00**
#234AM	0-300 volt 500 ma	**55.00**

CV-253/ALR 30-1000 mc CONVERTER

Written up in "73" mag. for June. A rare and valuable item. 4 units available. Like new of course. **$135.00.**



COLLINS ARR-15 RCVR 1.5-18.5 mc

Written up "73" June. Tuneable with Collins PTO and calibrator. 45.00

FREQUENCY METER LR-3 85.00

SILICON DIODES SPECIAL

800 PIV 400 ma	**$3.00/12**	**30¢** each
1000 PIV Studs 2 amp	**$10.00/12**	**$1.00** each

Above is a small selection of choice surplus from our large 72 page illustrated catalog. Send 20¢ production & handling cost for catalog.

JOHN MESHNA JR.

19 Allerton St., Lynn, Mass.

Index to 1965

INDEX TO ADVERTISERS

Propagation Chart

January 1966

J. H. Nelson

Note: Through a printer's error, the propagation chart that ran in the December issue was the September one.

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	7	7	7	7	7	7	7	7#	14	14*	14
ARGENTINA	14	7#	7	7	7	7	14	14	14	21	21*	14
AUSTRALIA	14	7#	7#	7#	7	7	7	14	14	14	14	14*
CANAL ZONE	7*	7	7	7	7	7	14	14	21	21	14*	14
ENGLAND	7	7	7	3	7	7#	14	14	21	14	7#	7
HAWAII	14	7#	7	7	7	7	7	7#	7#	14	21	14
INDIA	7	7	7#	3#	7#	7#	14	14	7#	7#	7#	7
JAPAN	14	7#	7#	7	7	7	7	7	7#	7#	7#	14
MEXICO	7*	7	7	7	7	7	7	14	14	14	14	14
PHILIPPINES	14	7#	7#	7#	7#	7	7	7	7#	7#	7#	7#
PUERTO RICO	7	7	7	7	7	7	14	14	14	14	14	14
SOUTH AFRICA	7	7	7	7#	7#	7#	14	21	21	14*	14	14
U. S. S. R.	7	3	3	3	7	7#	14	14	14	7#	7#	7
WEST COAST	14	7	7	7	7	7	7	14	14	21	21	14

CENTRAL UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	7	7	7	7	7	7	7	7	14	14	14*
ARGENTINA	14	7#	7	7	7	7	7*	14	14	21	21*	14
AUSTRALIA	14	14	7#	7#	7	7	7	7#	14	14	14	14*
CANAL ZONE	14	7	7	7	7	7	7	14	21	21	21	14
ENGLAND	7	7	7	3	7	7	7#	14	14*	14	7#	7#
HAWAII	14	14	7#	7	7	7	7	7	7#	14	21	21
INDIA	7	7	7#	7#	7#	7#	7#	7*	7#	7#	7#	7
JAPAN	14	7#	7#	7	7	7	7	7	7#	7#	7#	14
MEXICO	7*	7	3	3	7	7	3	7	14	14	14	14
PHILIPPINES	14	7#	7#	7#	7#	7	7	7	7	7#	7#	7#
PUERTO RICO	7*	7	7	7	7	7	7	14	14	14*	14	14
SOUTH AFRICA	7	7	7	7#	7#	7#	14	14	21	14	14	14
U. S. S. R.	7	3	3	3	7	7#	7#	14	7*	7#	7#	7

WESTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	7	7	7	7	7	7	7	14	14	21
ARGENTINA	14	14	7#	7	7	7	7*	14	14	21	21*	21*
AUSTRALIA	21*	21	14	7#	7	7	7	7#	14	14	14	14*
CANAL ZONE	14	7	7	7	7	7	7	14	21	21	21*	21
ENGLAND	7#	7	7	7	7	7	7#	7#	14	14	7#	7#
HAWAII	21	14	14	7	7	7	7	7	14	21	21	21*
INDIA	7#	14	7#	7#	3#	7#	7	7	7	7#	7#	7#
JAPAN	14*	14	7#	7	7	7	7	7	7	7#	7#	14
MEXICO	14	7	3	3	7	7	3	7	14	14	14	14
PHILIPPINES	14*	14	7#	7#	7#	7	7	7	7	7#	7#	14
PUERTO RICO	14	7	7	7	7	7	7	14	14	21	21	14
SOUTH AFRICA	7#	7	7	7#	7#	7#	7#	14	14	14*	14	14
U. S. S. R.	7#	7	3	3	7	7#	7#	7*	7*	7#	7#	7#
EAST COAST	14	7	7	7	7	7	7	14	14	21	21	14

\# Very difficult circuit this hour.
* Next higher frequency may be useful this hour.

Good: 3-6, 8-16, 18-20, 24, 25, 28-31

Fair: 7, 17, 21, 23, 27

Poor: 1, 2, 22, 26

VHF DX: 4-10, 15, 16

got a match?

Definitely not. It's a cold fact that no competitive linear amplifier compares with National's NCL-2000 -- regardless of price. Take the time to look at the chart below and plug in the specs of *any* amplifier next to those of the '2000 — not a single competitive unit in the maximum power classification offers even half the features of the NCL-2000:

FEATURE	NCL-2000	COMPETITION
POWER	Entire equipment I.C.A.S. rated for full 1000 watt average, 2000 watt peak input; output tubes and all RF components rated for C.C.S. operation. Power input and efficiency identical on all bands — 80 through 10 meters.	
SIZE	Completely self-contained, including power supply, in desk-top cabinet (dimensions only 7⅝" H, 16¼" W, 12¾" D).	
DRIVE REQUIREMENTS	Adjustable passive grid input and use of high power ceramic tetrodes in final permits drive to full output with exciters delivering as little as 20 watts or as much as 200 watts.	
METERING	Separate rear-illuminated precision D'Arsonval plate and multi-meters for simultaneous measurements.	
ALC	ALC output to exciter for maximum talk-power with greatest linearity.	
SAFETY AND PROTECTIVE DEVICES	Fuses, time delay and plate current overload relays, plate power lid interlock and automatic HV mechanical shorting bar.	
CLASS OF OPERATION	Grid-regulated AB_2 permits easiest tune-up, low drive power for maximum exciter linearity, and protection from destructive peak currents.	
EASE OF TUNE-UP	Internal dummy load in grid circuit makes adjustment of exciter into amplifier possible without turning on NCL-2000 and without radiating a signal.	
STYLING	Award-winning design matches NCX-5 transceiver and complements any equipment.	
GUARANTEE	National's exclusive One-Year Warranty.	
PRICE	Only $685.00.	

The NCL-2000 is a rock-crusher of a rig built to *commercial* standards. That's why you get I.C.A.S.-rated maximum legal power in a one-piece desk-top package, and why you get ALC and drive power compatibility with high quality exciters. It's why you get two precision meters, and sensible protection afforded by proper safety devices. Match the NCL-2000 with all the others before you buy — then see your National dealer for easy terms and trade-in deals.

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73

Amateur Radio

FEBRUARY 1966
A Fizzly 50¢

OSCAR IV IS UP!
SEE PAGE 110

73 Magazine

Wayne Green W2NSD/1
Publisher

Paul Franson WA1CCH
Editor

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de W2NSD/1

never say die

Africa?

Dxing is insidious. Back last spring, when I got on twenty meters, Europe was pouring through all day long. After a few weeks of this I was ready to go and I went. Now the band is open to Africa every afternoon right on into the evening. As I talk to more and more African stations I find that the old memories of Jungle movies are coming back. About thirty years ago they had a passel of them and I used to sneak downtown after high school to see them. And I read the Osa Johnson books avidly. I'd polished off the Tarzan books some five years earlier.

Now, as I find myself creaking well into middle-age, I get to thinking how much fun it would be to take a drive through Africa in a Land-Rover or to perhaps shoot a lion. If I'm going to do anything like this it has to be pretty soon . . . while I can still do things . . . and while Africa is still relatively unexplored.

Are there, perchance, among the readers, any who are thinking along similar lines? Would any of you be interested in driving around Africa this coming summer . . . August and September? We'd take along a ham station, of course, and operate from as many rare countries as possible. We'd work in a safari and shoot a lion or so, and perhaps even a leopard. It may not be long at all before a trip like this will be impossible . . . any takers? It'll cost quite a bit, but it will be something you'll never forget.

Too much hamming?

Impossible, you say? Well, I got to mulling over how much time I've been putting in on twenty meters recently and came to the conclusion that I was close to being hooked by the DX bug and that I'd better ease off before it was too late. I found myself turning on the rig when I got up in the morning, again during the 10 a.m. coffee break . . . then at lunch, mid-afternoon, late afternoon . . . evening . . . and then there was that marvelous DX on 80 meters from sundown until two or three.

With all that activity I haven't missed much that has been going on. Oh, I lost one or two while I was away for a few days on trips here and there, but that was about all.

Working 100 of what the League quaintly calls countries during a two week blast back in April got me started. It has been difficult to stop. I am still finding a new one every day or so. As this is written I am at 173 worked. Probably the best bet is for me to keep at it for 27 more and then "retire" at 200. Then I can devote my energies to getting up to 100 on 80 meters, which should be a little more difficult.

There are so many interesting and enjoyable things to do in amateur radio that I really shouldn't spend all my time on just one aspect of it like this.

No, you won't find me listed in QST in the DXCC lists. My fun is in working them, not in seeing my call is QST. It gets there all too much already.

Possibly others will join me in my retirement when QST stops printing the honor roll each month and cuts back to twice a year. I hope so. The DX ops would have a much better time of it is they weren't harassed by QSL hunters.

FCC pronouncements

The Commission has announced that henceforth it will conduct operator examinations semiannually in Las Vegas. Say . . . can we cut double or nothing for the fee?

Time to fight?

The intruders in our amateur bands are getting worse and worse. CW, RTTY, multiplex, broadcast and other unidentifiables are gradually pushing us right out of our bands. Our feeble attempts to complain about this have fallen on deaf ears and for every signal that is eventually removed from our bands there seems to be ten to take its place.

The worst offenses are on 40 meters, of

course. Here we not only have to contend with foreign broadcast stations, but our own umpteen kilowatted VOA are staked out every few kc through a good part of the band as I reported in detail a couple months ago. Add this to a few hundred 40-over nine RTTY stations and a few other services that have settled in our happy hunting ground and you have the bedlam that faces the 40 meter operator.

Or have you tried 80 recently. If you've been off the band for a couple years I guarantee you won't even recognize the band today. The 100 kc expansion of the phone band from 3900 to 3800 (thanks NARC) has largely been taken away from us again, this time by commercial RTTY. And you should hear the stuff the Canadian phones have to brave between 3750 and 3800!

So, what should we do? Shall we just move over and grumble about it? Should we send in an intruder report to the FCC? Or can we fight back with a little more backbone?

Vigilantes?

Obviously we are getting nowhere fast in our present unorganized state. I'd like to see a group on each of our ham bands which would meet as a net and pinpoint these intruders. Then I think that every means within our grasp should be used to force these stations out of our amateur bands. Just a handful of amateurs working together could, I believe, clean our bands up in short order.

Vigilante net members should have a direction finder at the very least. RTTY equipment will be needed to identify many of the stations. Some of the high speed CW can be taped and identified. The FCC and ITU will help locate the sources if we can get the call letters. Then we can get the FCC and ITU to pursue a complaint against the station with the government involved. We can also make it our business to use the intruder frequencies, thus showing them that these channels are indeed needed by the amateurs.

Wouldn't it be nice if some of the fellows who spend their amateur lives making things as miserable as possible for the rest of us could channel some of their energy toward making things unpleasant for intruders. Down on 80 it is almost impossible to work a real DX phone station without a very loud CW station calling a long halting CQ on the channel. That CW signal would raise hob with an RTTY station.

For that matter I am sure that some of our

(Continued on page 120)

Paul Zukin W6OVW

An 8163 Linear

For 2000 watts PEP on 80 through 10

In recent years many designs for single side band linear amplifiers have been offered the amateur interested in constructing his own equipment. This amplifier is neither original nor unique but does have several features which the author believes most desirable. A pair of modern relatively inexpensive 8163 high mu triodes are used. They have a combined plate dissipation of 800 watts and the ability to handle 2000 watts PEP with ease. The tubes are manufactured by Amperex and are specifically designed for grounded grid service. They need little cooling; a low velocity air flow provided by a small fan is plenty. This obviates the need for special sockets, chimneys, blowers or an air tight chassis. The elimination of these accessories permits a considerable saving in cost, and allows a physically smaller unit and one which is much quieter in operation.

This linear has been in service for the past six months and has proved extremely reliable and efficient. The total cost excluding high voltage power supply was under $150. It has replaced an amplifier using vacuum variable capacitors and relays and a 3-1000Z tube costing more than twice as much and nearly three times as large. The larger amplifier required considerable more drive but put out 5% less power with the same voltage and current input.

The circuit is standard. A band switching L network is used in the input to provide an optimum match for the exciter and to reduce intermodulation distortion. The filament choke is home made. A rotor coil was used as the inductor in the pi network but a band switching arrangement would serve as well. The counter dial is a readily obtained item on the surplus market. A surplus antenna relay operating on 110 volts dc was chosen since my 32S-1 provides 285 volts when the exciter is operative. This voltage is easily dropped to 100 volts with a 20 watt, 12,000 ohm series resistor. An alternative antenna relay system may be substituted for other exciters.

Since the high voltage supply is remote from the amplifier, interconnecting cables are

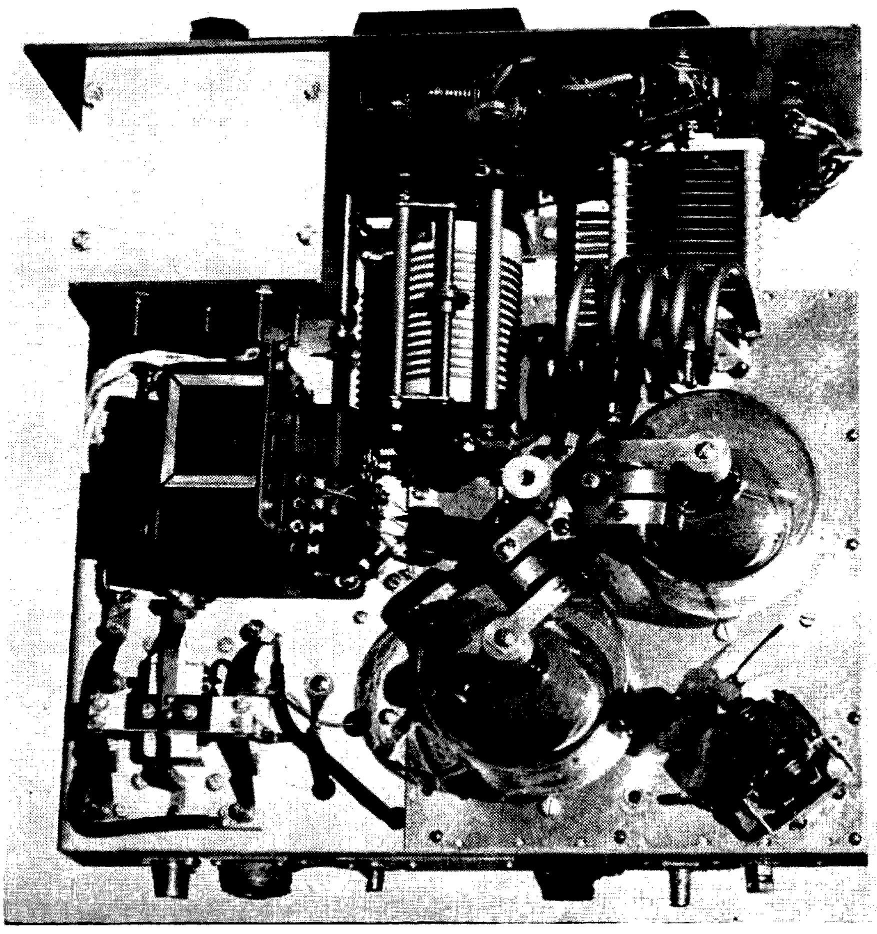
required. A touch plate relay has been employed to switch the primary off and on. This bargain ($4) is a standard item used in low voltage house wiring circuitry. It features a built-in 24 volt dc source and will switch 20 amps ac without difficulty. The advantage in its use is that control of primary switching is by three small wires carrying only low current 24 volt dc rather than a large cable carrying the entire primary power. Information regarding these relays may be obtained from any wholesale electric supplier.

The meter circuit monitors grid current, plate current, relative output (by means of a rectified sample of the rf and plate voltage. A 1 ma meter movement forms the basic unit with the necessary shunts and series resistors switched to perform the desired functions. The meter is shielded from rf. The author's power supply uses a 60 second time delay relay in series with the relay activating the primary of the high voltage transformer and the meter illumination pilot turns on automatically when the time relay closes. The details of the high voltage supply have been omitted since the amateur radio handbooks describe several excellent circuits.

The small size of the amplifier actually permits its construction in many of the enclosures used for commercial exciters and transceivers. The amplifier described here is housed in a cabinet obtainer from Master Mobile, Inc. and measures 7 x 13 x 13 inches and harmonizes well with the S line.

A few notes regarding construction detail may be of value. All the coils in the input circuit are wound on ½ inch slug tuned National XR-50 forms. The capacitors are 1000 v silver micas and the input circuitry is housed in a 4 x 4 x 2 inch aluminum case with small coax connectors for leads in and out. The tube sockets are Johnson "Giant 5 Pin." In grounding pins 2, 3 and 4 it is advisable to use ¼ inch copper strap keeping the leads as short as possible. The components in the rf sampling circuit must be shielded and may be conveniently mounted in an old can with the sensitivity control coming through the top hole.

The relay circuit employed automatically bypasses the amplifier with S_3 in the off position. With S_3 in the on position output from the exciter feeds into the amplifier (instead of the antenna) and the output of the amplifier goes to the antenna. The extra set of con-



Top view of the 8163 linear amplifier. Note the small blower in the right corner. The massive anodes of the Amperex 8163 explain why more cooling isn't required.

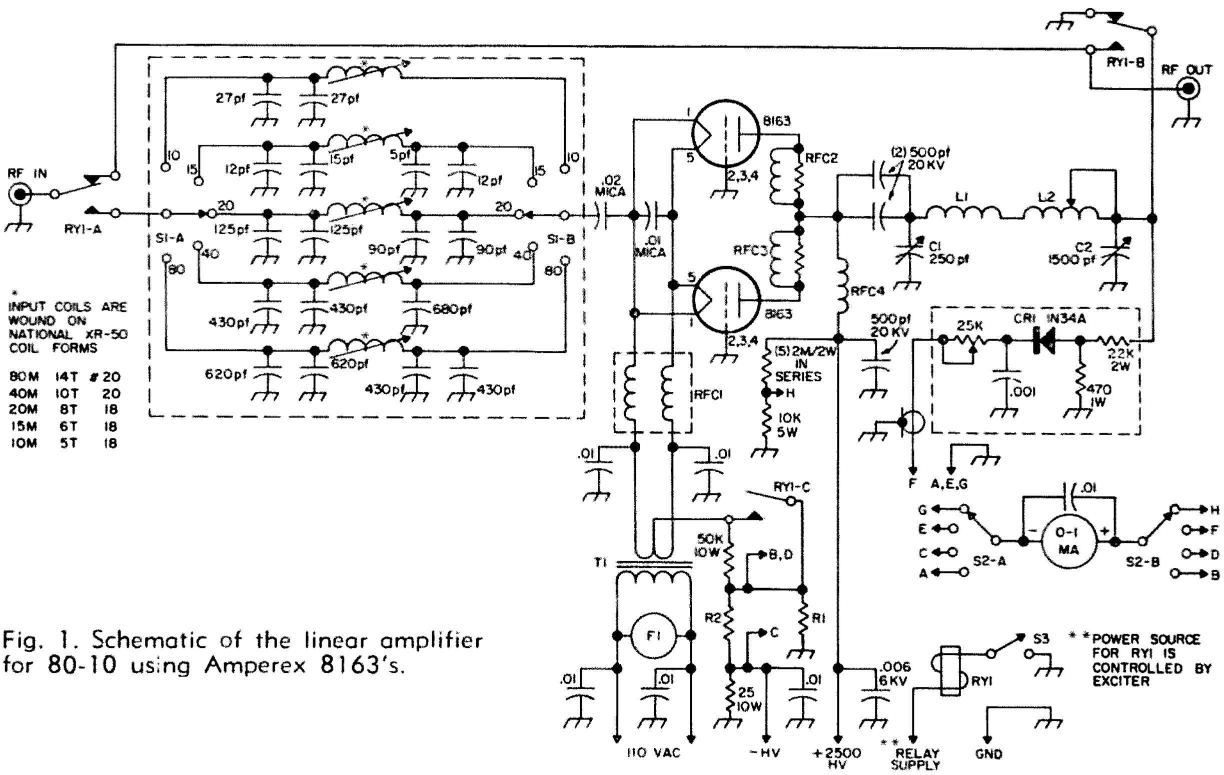
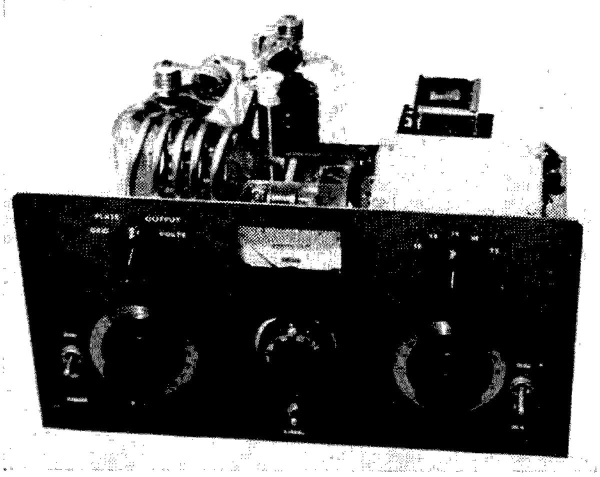


Fig. 1. Schematic of the linear amplifier for 80-10 using Amperex 8163's.

tracts on the relay are used to short out a 50,000 ohm resistor in series with the center tap of the filament transformer. In "receive" condition this resistor provides self bias for the tubes and they draw no current. In "transmit" shorting out this resistor permits the tubes to operate normally. A 25 ohm resistor is used between the chassis (ground) and the high voltage negative lead, keeping the meter essentially at ground potential. The meter shunts used will have to be chosen for the internal resistance of the meter movement. For the sake of simplicity both grid and plate current are measured on a 0 to 1 amp scale and the high voltage on a 0 to 10,000 volt scale. The meter used in the author's unit is particularly nice since all shunts are external and the translucent scales chosen simply slide behind a plastic compartment protecting the pointer.

The tune-up procedure should be well known to all amateurs and needs no explanation here. Adjusting the input network is simple. Feed a small amount of power from the exciter to the amplifier with the filament voltage on and the high voltage off, and with an swr bridge connected between the exciter and the amplifier. The slugs are tuned to provide a minimum of reflected power. In practice a 1 to 1 ratio is not difficult to obtain on bands. . . . W6OVW



A view of the amplifier out of its case.

Component List

C_1 Johnson, 154-9
F_1 Cooling Fan, Lafayette AYFA-403
L_1 5T ¼" copper tubing, 1½", 3" long
L_2 18 microhenry, Johnson 2291202
M_1 0-1 ma meter unit with 0-1 amp scale. (Phaostron Prestige II)
RFC_1 28 double turns, number 10 Formvar or Nyclad closewound on ½ inch diameter 7½ inch long ferrite rod (Lafayette Radio, NYC MS-333)
R_1, 2 meter shunts for 0 to 1 amp full scale with 0 to 1 Ma movement.
RFC_2, 3 ¼" copper strapping wound to form 3 turns, 1" diameter, 1½" long, around 3 220 ohm 2 watt carbon resistors in parallel.
RFC_4 B and W W800
RY_1 DPDT antenna changeover relay with extra set of contacts. (Hiway Electronics, 114 Venice Blvd., Los Angeles, California)
S_1 2 pole 6 position (5 used) ceramic rotary switch (Centralab, PA-2003).
S_2 2 pole 4 position rotary
S_3 SPST toggle
T_1 Thordarson 21F33

Ron Gunn WA6KLL
358 Albatross Ave.
Livermore, California

And Then There's Phasing SSB

Home brew phasing type generation of SSB signals has numerous advantages over filtering. First, the frequency is determined by the builder, not the manufacturer of some filter. Second, it is cheaper to build. Third, sidebands are selectable without changing carrier oscillator frequency. The method seems limited by a combination of apparent complexity and inconvenience in using. This article will attempt to explain the complex in simple terms as this is all the writer understands about it.

It is inconvenient when the generator operates on the output frequency and must be retuned completely to QSY. Modern practice, however, is to generate the SSB signal on some fixed frequency and then mix with a VFO signal to get to the ham bands. 9 mc has grown to be an accepted frequency for this sideband generator to operate on. When mixed with a 5 mc VFO the difference frequency is on 75 meters and the sum is on 20. Two meters is available by mixing the 137 mc from a string of multipliers with the exciter output and so on.

This article is different from the many excellent articles in the literature in that the purpose is to explain those things about building and operating these phasing rigs that recent articles have left out. Nothing new is contained here, but some of the simple things have not appeared in print for years as they are "well known". A person without a good reference library is therefore left out.

Fig. 1 shows a more or less typical 9 mc phasing exciter built using a Barker and Williamson audio phase shift network (B & W 350-2Q4). In principle this and other phasing exciters have three parts: The audio processing section, the rf phasing section and the balanced modulator. In the sample schematic this takes three tubes and a regulator.

The basic idea is to get two audio signals that differ from one another by 90°, and to combine these signals in a pair of balanced modulators connected to a common rf output transformer tuned to the rf (carrier) frequency. The result is a single sideband suppressed carrier output which is then mixed to get to the desired frequency and amplified to obtain the desired output power.

Audio circuits

The circuit shown is that recommended by B & W. Others tried have not worked as well. The purpose here is to split a single audio

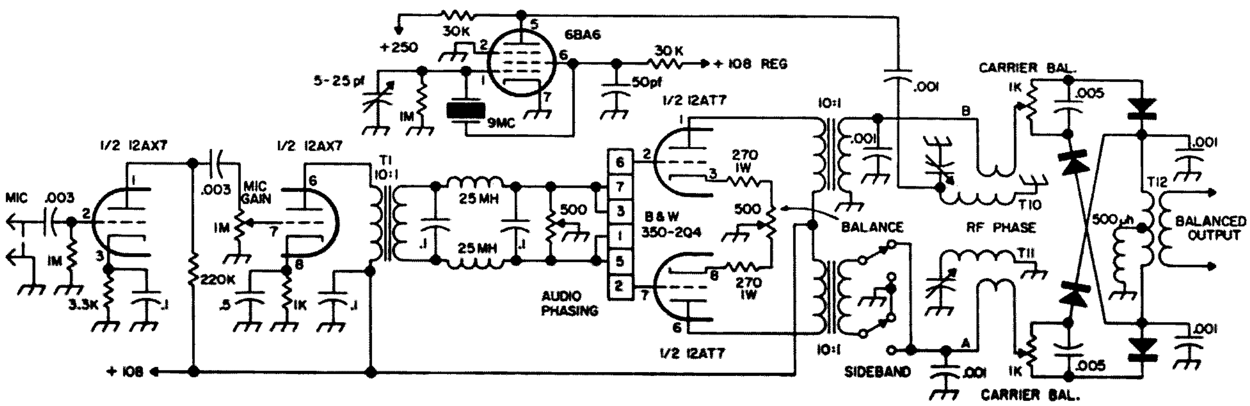


Fig. 1. Typical phasing transmitter. This is the schematic of the transmitter described in this article.

input into two separate outputs differing in phase by 90°. These two outputs are as individual as the two channels of a good stereo system. B & W rates their unit at 90° ±1.5° over the audio range of 300 to 3000 cycles per second. The 500 ohm AUDIO PHASING pot across the input to the network will end up adjusted off center by a ratio of 5 to 7. Don't worry, this is the way it is designed to operate. The two outputs must not only differ in phase by 90° but must be equal in amplitude for proper unwanted sideband cancellation. The 500 ohm BALANCE pot in the cathode circuits of the audio section output amplifiers is provided to set this, and need be touched up only occasionally as the components age.

Design of the preamp driving the phasing network must take into account the frequency range of the network. The high turns ratio of the transformer into the network is intentional and tends to shunt frequencies above the communications range. This turns ratio is 10:1 for an impedance ratio of 100:1. Smaller

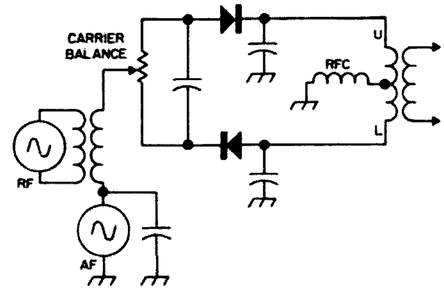
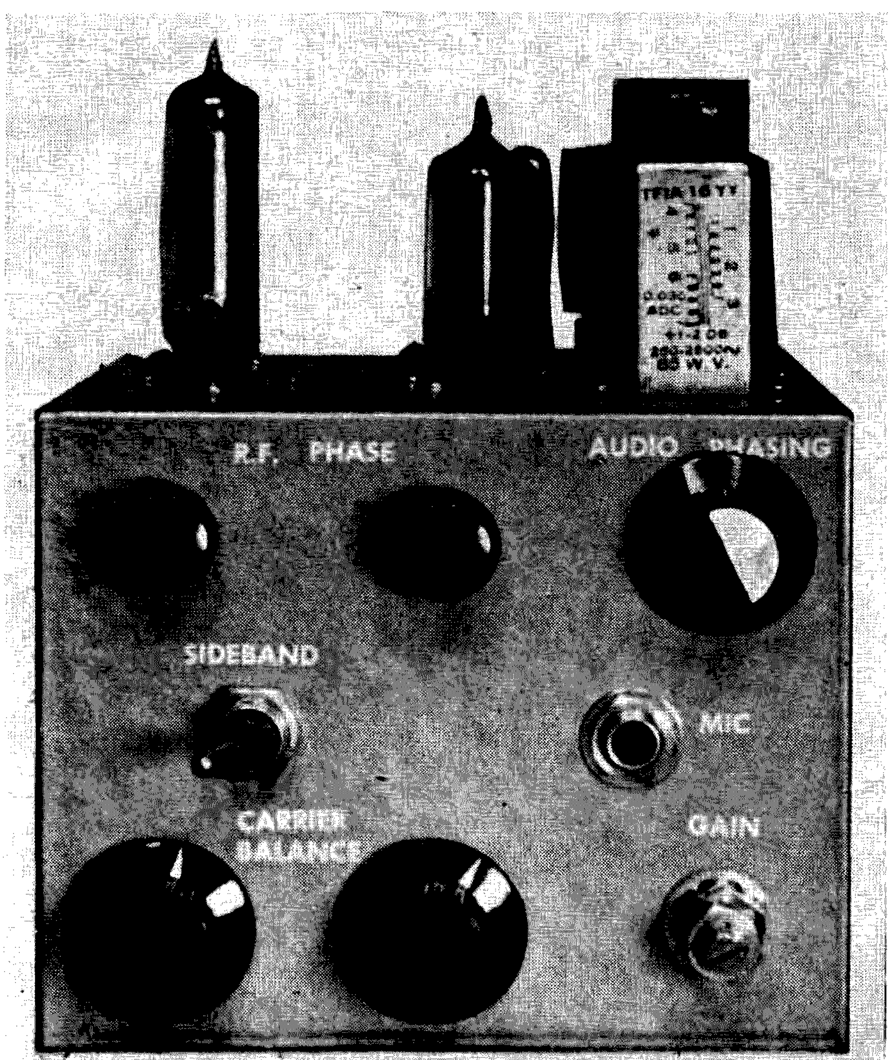


Fig. 2. Balanced modulator as used in this exciter.

coupling capacitors and cathode bypasses tend to hold down the lows. The low pass filter network in the secondary of T1 insures that there is adequate rejection of the higher frequencies which will show up as chatter on the unwanted sideband if allowed into the phasing network.

The effect of excessive lows will be increased difficulty in tuning your signal at the receiving end, because most energy below 300 cps will appear in both sidebands. The



Front view of the phasing SSB exciter. The audio balance control is on the rear. Note that **mic gain** is a screwdriver adjusted control.

effect of excessive highs will be a chatter 3 kc and more away from your carrier frequency on the unwanted sideband side. These are design, not tuning problems.

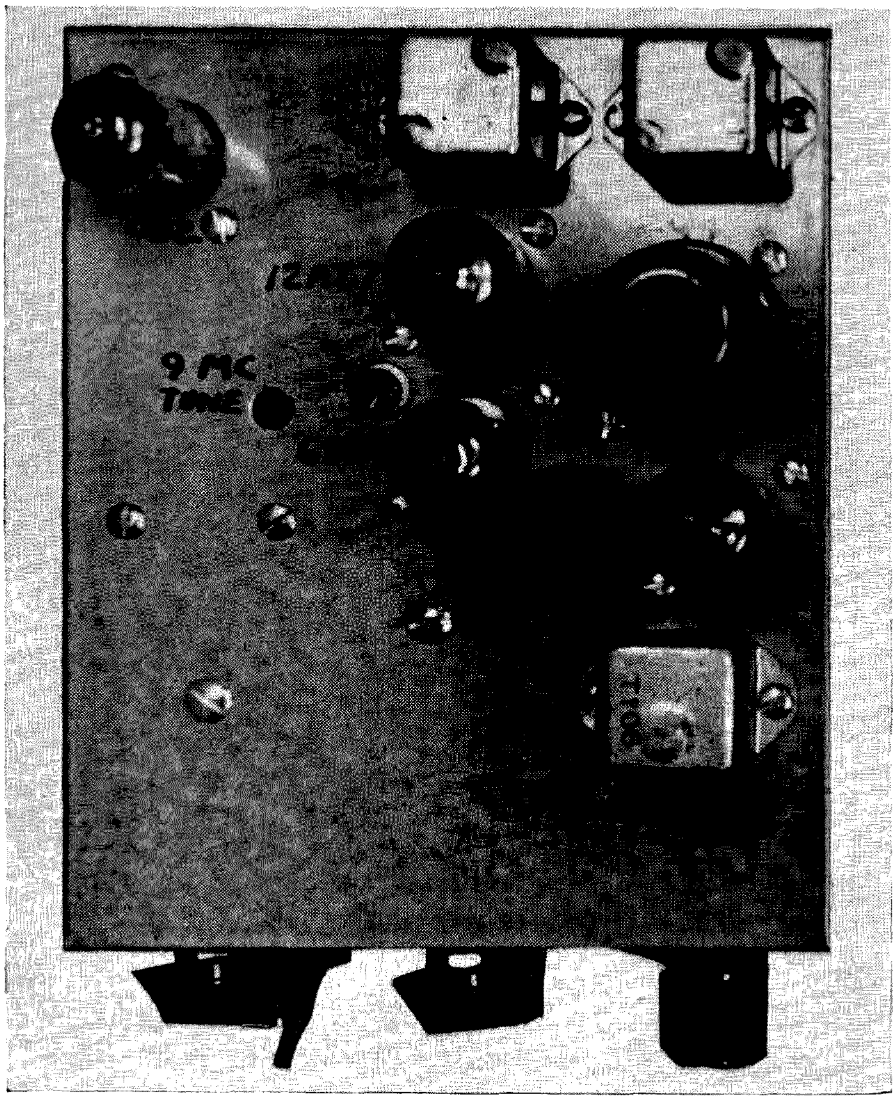
To sum it up, the output of the audio section consists of two individual audio outputs which are confined in range to the upper and lower limits of the phasing network and which are quite precisely 90° out of phase with each other and equal in amplitude. We can call them A and B and will pick them up later.

RF circuits

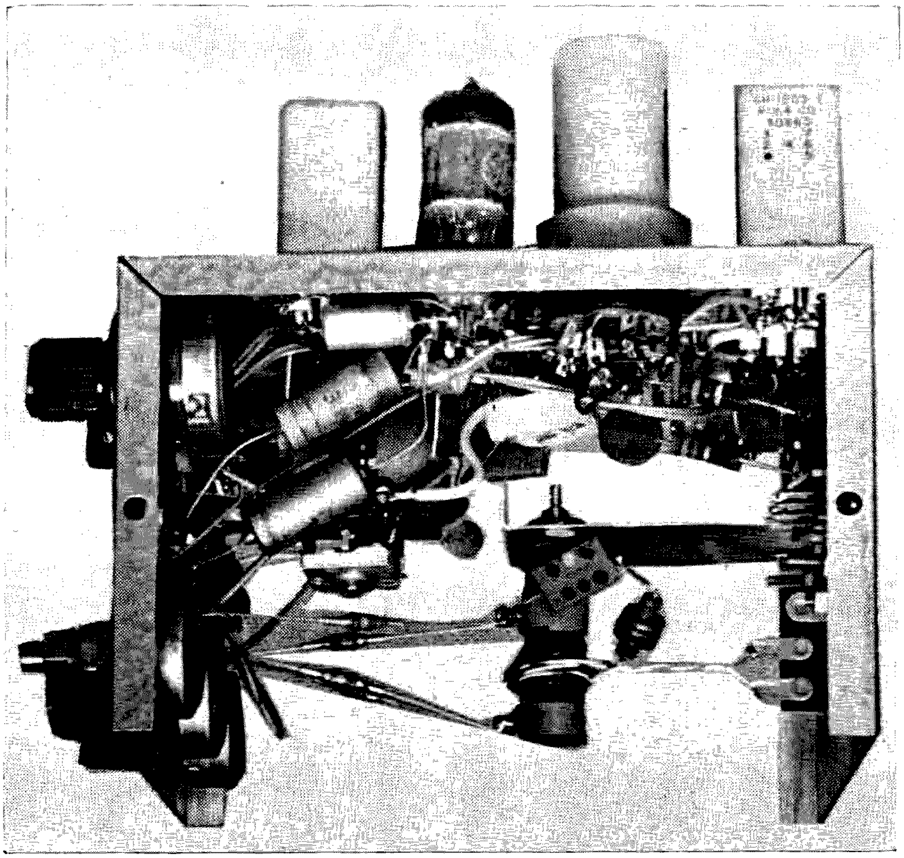
An electron-coupled, crystal controlled carrier oscillator at 9 mc is used as the rf source. T10 is tuned to the output frequency of this oscillator. T11 also tunes to the same frequency and is driven by T10. The oscillations in the two tuned circuits are 90° out of phase when properly tuned. The amplitudes of these oscillations should be fairly equal. Large inequality between these two outputs as measured at the swinger of the CARRIER BALANCE pots will show up in the form of less unwanted sideband cancellation (suppression). Adjustment of this amplitude may be accomplished by varying the distance between the two coils or by installing a small capacitance (gimmick) between the two.

Tuning adjustment for T11 (and incidentally T10) should be readily accessible to the operator (not a screwdriver adjust function) as T11 will have to be touched up if the unwanted sideband cancellation seems to be drifting up. The Q of these transformers should be about that obtained by using 70 pf to tune the inductors to the required 9 mc.

Wiring from the rf transformers thru the output should be symmetrical. Balance becomes more difficult when there is, for instance, more capacity from one set of diodes to ground than the other. The link output on T12 must be on the center of the coil, and it must present a balanced load. Otherwise, carrier balance will be impossible and, in



Top view showing parts layout. **9 mc tune** is the adjustment for the output control.



Side view of the exciter showing parts layout. The audio section is nearest. Note the output transformer on the right.

short, it won't work.

The two outputs from the rf phase transformers are obtained by winding a couple of turns of hookup wire around the cold or grounded end of the coils. The audio outputs A and B are connected to one end of these links while the other end goes to the swingers of the CARRIER BALANCE pots. The .001 bypass in each audio circuit should be installed right at the rf link if the wire run is long. The swinger of each pot ends up with pure audio and pure rf signals on it, unmixed. Mixing takes place in the balanced modulator.

Balanced modulator

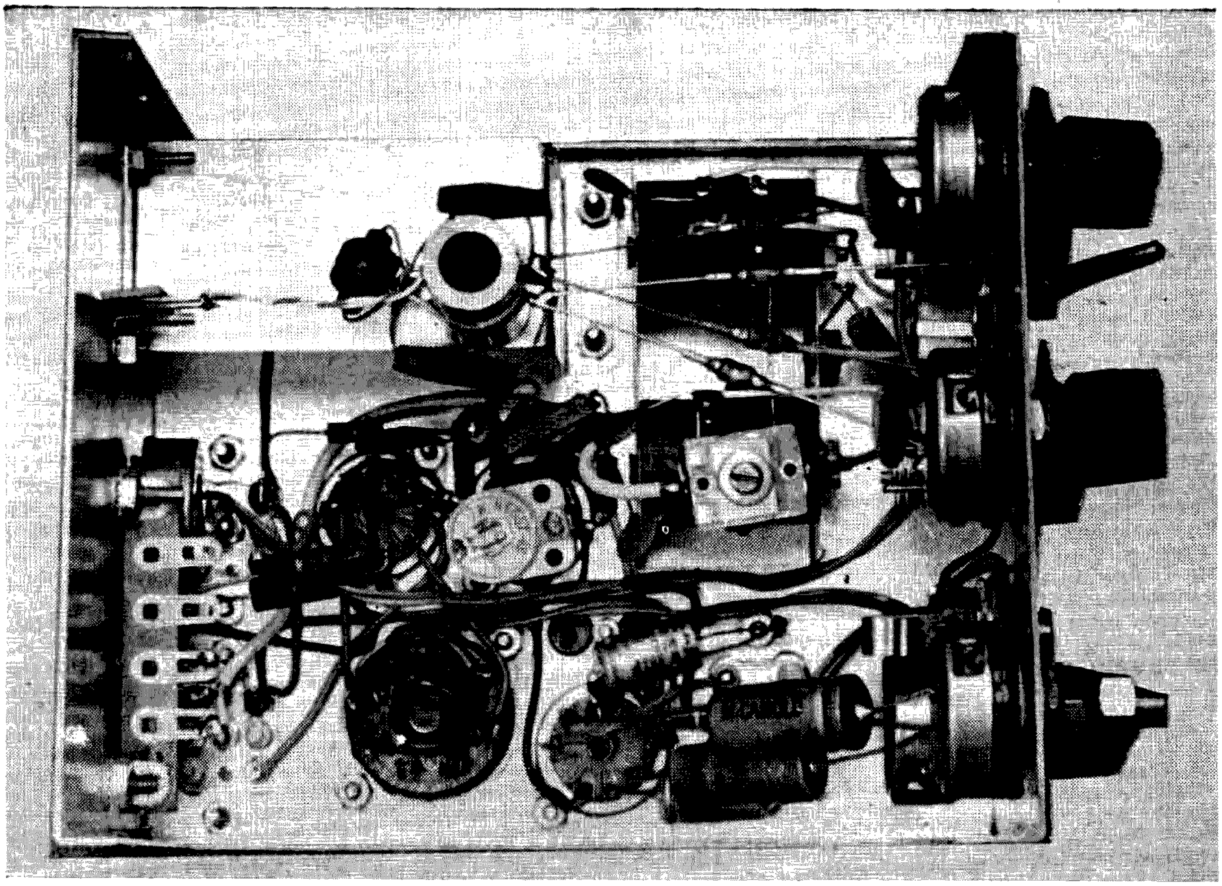
The two CARRIER BALANCE pots are carbon as they must pass rf. The amplitude of the rf signal should be at least three times the audio. This rf signal is used to switch the mixing diodes on and off while the audio signal determines the maximum value to which the mixed signal can go. The rf must therefore be much greater than the peak of the audio.

Many types of signal diodes can be used, though all should be selected for compatability if practical. This consists of checking the forward resistance of a number of units and taking the four that are most alike.

Looking at **Fig. 2** now, let's imagine that the tuned circuit on the right is set at 9 mc. When a positive cycle is generated, it goes thru the upper diode and pulses the tuned circuit, driving point U positive. A half cycle later, point U is negative and point L has become positive. At this same time the source is applying a negative cycle thru the lower diode, also to point L. The positive and negative at point L cancel, and there is no output. This is true as long as the upper and lower diodes are conducting the same, any small variations being compensated for by the CARRIER BALANCE pot.

When audio appears, it tends to turn one of the modulator diodes on while turning the other one off. This allows unequal positive and negative cycles thru to the tuned circuit and they do not cancel, thus producing an output whose amplitude varies at an audio rate while superimposed on a radio frequency signal. This output is not distinguishable from a set of sidebands with no carrier. When two of these are properly phased in relation to one another and are connected to a common rf transformer, one sideband adds while the other neatly cancels out.

Note that each of the two balanced modulators produces both upper and lower sideband output while removing the carrier. The actual elimination of one of these sidebands is done



Bottom view. The terminal strip on the upper left is for all power connections to the rig.

by cancellation in the tuned circuit to which both are connected.

The 500 μh choke connected to the center of T12 is an absolute necessity. An attempt to build a simple SSB rig from a schematic where this choke was omitted resulted in a frustrating week spent seeking the answer. This choke is the return path for the audio signal fed into the balanced modulator, but must hold the whole tuned circuit away from RF ground or the very important 180° difference across the circuit will not be maintained.

Tuning up

Once the SSB exciter is tuned up and operating into a mixer stage there is no need to do more than touch it up occasionally. It will be desirable to null the CARRIER BALANCE pots as in any kind of SSB exciter, but the only other attention it will need is an occasional check of the unwanted sideband rejection. Start by injecting a 2 kc signal into the MIC input. Tune the tone in with a sharp receiver on the unselected sideband and null it out with the RF PHASE and AUDIO PHASING controls. Switch sidebands a couple of times, nulling the unwanted sideband each time, and the job is complete.

A little bonus here for those who are not too familiar with phasing rigs and have read this far: SI is the sideband reversing switch. To go from one sideband to the other in a phasing rig it is necessary only to reverse one of the two audio outputs. This question is in practically every FCC Technician and General Class exam issued.

An oscilloscope is very handy when one of these rigs is being tuned up for the first time though with patience it can be done like the touch up in the next to last paragraph. For the complete tune up: put a 2 kc sine wave tone into the MIC input and advance the GAIN control a little. Referring to **Fig. 1**, connect the horizontal and vertical inputs of the scope on audio output A. Adjust the gain on both inputs for a perfectly diagonal line (same number of divisions across as up). Now put the horizontal on the other audio output B. Adjust AUDIO PHASE and BALANCE to get as good a circle as is possible. Advance the MIC GAIN until the circle is as large as practical before it distorts. Remove the tone. Talk into the rig with the microphone that will be used. Adjust the MIC GAIN so that the hash on the screen is not larger than the circle that was

there. Do not operate with more MIC GAIN than this as all kinds of distortion can result. Instead, look for power gain elsewhere.

Now turn on the 9 mc oscillator. Put the antenna lead from a selective receiver near the output of the rig as a sensitive output meter. Tweak the capacitor in the oscillator grid for maximum out. Tune T10 and T12 for max out. Tune T11 to as close to resonance as is possible at this time. Go back and forth adjusting the CARRIER BALANCE pots for minimum output until a null is obtained. Unbalance one of the pots and make sure T10 and T12 are at maximum, then renull.

Introduce the 2 kc tone, being careful not to overdrive the audio system as mentioned before. Using the selective receiver, find the weakest sideband (if there is one). Flip it from upper to lower (using S1) to check. When the weakest is found, tune on it and adjust the AUDIO PHASING, BALANCE and RF PHASE (T11) to null it out. Be careful to go from upper to lower and back repeatedly, always nulling the unwanted sideband, until either is at full null when selected by the sideband selector switch S1. The rig is now on SSB, only one of the tones being present at any given time.

It is possible to null out one sideband, say the lower, without having the upper nulled out when sideband selector switch S1 is flipped. This is why it is necessary to go to the trouble of going from one sideband to the other to get a genuine switchable null. Both sidebands have the same carrier oscillator frequency and, once adjusted, are selectable at will using S1.

The exciter shown in the photos was built from the typical schematic (just to be sure) and works FB. The intention here has been to foster understanding of these rigs. Since many excellent construction articles exist there seems to be little need for more specific information of that type.

The following bibliography contains a few construction articles for those interested, plus the sources from which this article was lifted.

. . . WA6KLL

Photographs by Alan Pemberton WA6LEU

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Ralph Roanhaus
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Port Hueneme, California

Better Selectivity for Your Transceiver

Use a crystal filter for better CW performance

The recent trend towards transceivers in amateur communication equipment has given the owner a very fine piece of equipment for either mobile or fixed SSB work. It has, however, also given him a very inadequate receiver when he desires to use the unit for fixed station CW work; the 3 kc selectivity characteristic being far to broad for good code communications. It would seem that a narrow passband for CW would be a very desirable feature to have built in, but, since it almost universally is not, some external unit to accomplish this is very much in order.

Over the past year numerous, and in some cases quite effective, devices have been designed to improve the overall selectivity of such receivers. Usually however they suffer from the common deficiency of insufficient skirt selectivity which leaves the receiver open to strong adjacent channel interference and, since "adjacent channel" usually means six or seven signals, this can and does wash out many contacts which would otherwise be completed. The device to be described here improves this skirt selectivity and when used with an outboard audio filter such as described in the July 1962 issue of 73 does just about all that is possible to do to insure good contacts under the present conditions.

A glance at the schematic (**Fig. 1**) shows the unit to be an outboard 455 kc, two section, half lattice crystal filter with a product detector and an audio amplifier. A small built-in power supply furnishes the unit with heater and plate voltages, however, it might be possible in some cases to extract these voltages from your receiver as the requirements are not large.

The selectivity curve for this amplifier (**Fig. 2**) is approximately 200 cycles wide at the −6 db point and fans out to approximately 700 cycles at the −30 db point. The overall width of the response curve for a filter such as this can be changed by the proper choice of crystal sets. Crystals spaced farther apart in frequency will broaden out the top of the curve and still leave the skirt characteristics substantially the same. Careful alignment of a filter of this type is necessary, especially so when you use wide spaced crystals, otherwise you will have a response something like that of **Fig. 3**—the chances are this is what you will get when you finish your first rough alignment anyway. You can however, by carefully setting the rf generator to the center frequency between the two crystals,

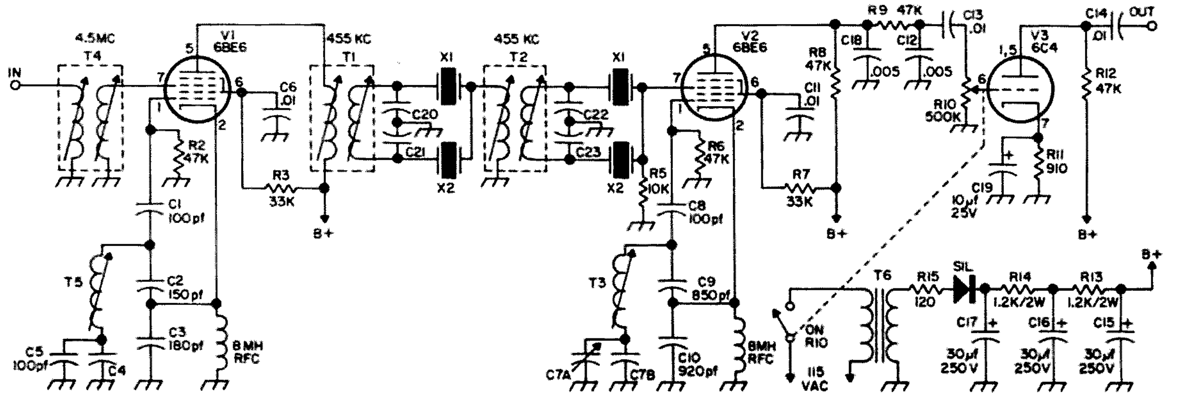


Fig. 1. Schematic of the outboard crystal filter CW adapter for SSB transceivers.

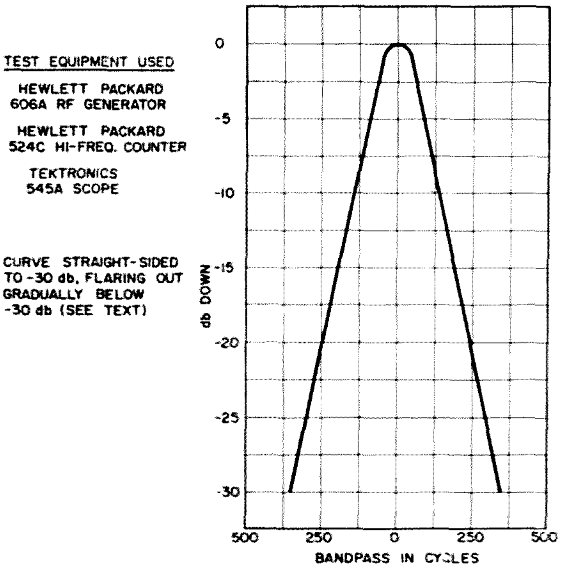


Fig. 2. Response curve for two section filter using crystals for channels 41 and 321.

fill in the center dip as you bring the *if* transformers into resonance, and increase the gain at that frequency. In case you do use wider spaced crystals you probably will need to stagger tune the *if* transformers to get a flat top to the response curve. This is no problem at all if you happen to have a sweep generator and not a very difficult one with only a rf generator and an output voltmeter.

Just in case you do have a sweep generator and happen to be a perfectionist you can also improve the skirt selectivity in the −30 to −50 db range by carefully balancing the capacity between the two halves of your lattice filter. The flaring out of the otherwise quite straight sided response characteristic is largely caused by capacity unbalance. An improvement in the skirt selectivity can also be obtained by the addition of more crystal sections. This complicates the alignment however, so is not particularly recommended unless a sweep generator is available.

The coupling from the receiver to the unit can be accomplished in several ways. The method shown in **Fig. 4** uses a small (10 pf) coupling condenser connected to the last *if* stage of the receiver, right at the point where it enters the detector stage. This will detune the last *if* transformer a little and will require a small adjustment of it's slug, but this can be left until last when it is easily accomplished by watching the S meter of your receiver. Just in case you do not wish to solder anything in your new receiver it is possible to get enough signal to operate the unit by simply making a few tight wraps of insulated wire around the lead coming from the last *if* can instead of installing the condenser. Five or six turns should be sufficient but put on more than that if possible. The *if* voltage from this coupling capacity is then brought out, preferably through a small BNC or an RCA jack on the rear of the chassis, to a short piece of co-ax going to the input of the outboard unit. Keep this co-ax lead as short as possible to avoid undue losses and the detuning of the *if* coils at each end.

The input *if* transformer used (**Fig. 1**) is one of the 4.5 mc type tuned, in this case, to the receiver's *if* of 3 mc. In case the receiver you have uses an *if* of a different frequency this transformer must match what you have of course. With the loading effect of the co-ax the input of this 4.5 mc transformer should resonate at the desired 3 mc with no trouble, if not it may then be necessary to shunt the input coil with a small condenser of 10 to 20 pf, a little cut and try may be necessary here as your co-ax lead length has a definite influence. The output coil of this transformer will require a small shunting condenser to bring it down to the 3 mc frequency also—again some cut and try may be necessary.

The first converter uses a 6BE6 tube in a standard mixer circuit with the oscillator operating on a frequency of 2545 kc, which, when beating with the incoming frequency of 3 mc, gives the proper *if* frequency for the unit. In case you have a different *if* frequency which will require a different oscillator frequency, care must be exercised to insure that the oscillator will not have harmonics which fall inside the ham bands. These can be picked up by the receiver and can be very annoying.

The output transformer for the 6BE6 is a standard 455 kc job with the secondary split by two 100 pf condensers. In the remote case that this secondary cannot be brought into resonance it will be necessary to change the

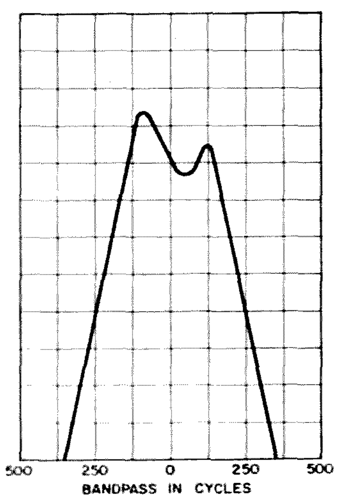


Fig. 3. Typical untuned response curve for two section filter.

value of these two condensers slightly. This probably will not be necessary however.

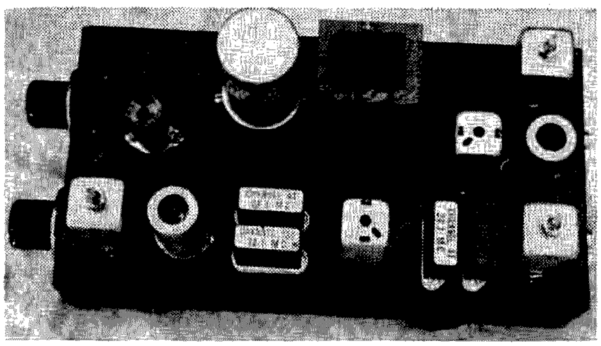
The four crystals are rather common on the surplus market and are obtainable for a very modest price. They come in FT241 type holders and are marked in channel numbers. The ones used for this filter are marked channel 41 and 321 (two each) which are for the narrow passband.

The second *if* transformer between the two crystal filters is identical with the first. Here again it may be necessary to pad the windings with a small condenser of 20 to 30 pf on the input and perhaps larger than the specified 100 pf on the output. This is not a difficult job as you can see as you tune up the coils that you can't quite reach resonance with the slug and you can also see with a trouble which way you must go to reach resonance.

The second 6BE6 is a product detector which is an excellent detector for CW as well as SSB. The oscillator section of this tube beats with the 455 kc signal to form the beat note for CW and the carrier insertion for SSB (it's understood that you must use a wider passband for SSB than the one described here of course). The tuning condenser is used to select either upper or lower sideband and can also be used for fine tuning of SSB. To adjust this oscillator simply set the condenser half way in and adjust the coil slug for zero beat with the 455 kc signal, the two sidebands, upper and lower, will then be on one side or the other of this zero beat.

The output of this stage then goes through a small filter to take out the rf and on through a gain control into the 6C4 amplifier stage. The output of this stage can be reinserted into the receiver's audio system or amplified by a power stage of af and used directly with it's own speaker. In the case of this unit it is amplified by the 6C4 and used only with headfones.

Probably the best way to "tune up" the unit is to set a rf signal generator to 455 kc and insert a fairly strong signal into the grid (G2) of the product detector (the second 6BE6),



Top view of the outboard CW adapter.

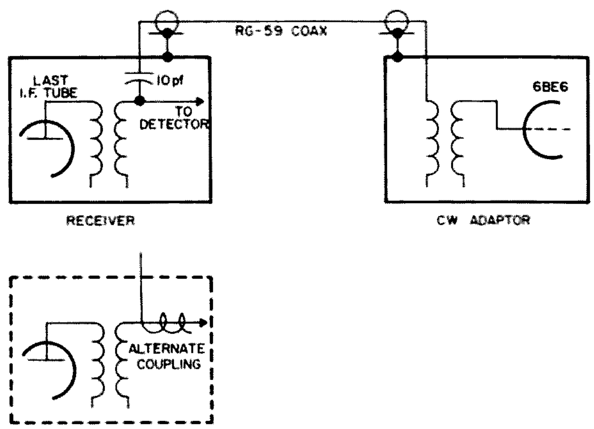


Fig. 4. Connecting the adapter to a transceiver.

then tune up the BFO and check your audio circuits. If these operate properly, go back to the input of the second *if* transformer (T2) and, after inserting the two following crystals, tune up the *if* transformer. You can then set your oscillator to the exact center frequency between the two crystals and touch up your BFO coil slug. Now move the generator back to the input grid (G2) of the first 6BE6 and, after disabling the oscillator section by shorting the coil T5 and inserting the remaining two crystals, tune up the first *if* transformer. For the last adjustment retune the generator to the receiver's *if* and insert this into the input of the unit and adjust the conversion oscillator to the proper frequency to give the 455 kc beat. Don't forget to remove the short from T5.

Now if you have installed the input *if* transformer T4 tune it up and you are finished except that you probably will need to touch up the slug in T5 when you tune in a signal with your receiver in order to get it right on frequency. All these adjustments sound difficult but can be accomplished with a simple rf generator and a reasonable good ac voltmeter.

The unit is built in a 5 by 9½ inch aluminum chassis with the input and output jacks on the rear apron. The two controls on the front are the audio gain, which also has the power ON-OFF switch and the bfo oscillator condenser. This condenser, as called out on the parts list is a 35 pf job which might be a little larger than you will like—making the adjustment a little critical—so you may, if you wish, reduce its value a small amount and increase C7B by a like amount. No special care or skill is required to build or adjust this unit, anyone who has done any receiver work at all should encounter no difficulty—it is even possible to align the unit using nothing but a signal generator and your ear, optimum performance would be an accident in that case however.

One or two general comments—care must be taken with the first conversion oscillator construction. If this oscillator drifts, your converted frequency will drift right through the narrow filter passband. In this case when you first turn the unit on there will be no output, then as the drift builds up the output will increase to a maximum and then go back to zero as the oscillator drifts the frequency on by. It depends, of course, on just where in the drift time you originally set up the tuning, but in any event a drift can play hob with your results. The oscillator could well be crystal controlled but you probably will need to spot the crystal yourself so if you like to grind crystals to spot frequencies by all means try it.

The only reason for the first *if* transformer in the unit is to isolate the conversion oscillator from the receiver, as any oscillator voltage getting back into the receiver's avc circuits will give a constant S meter reading with no signal input. The isolation of the 6BE6 is quite good however, so if you wish to cut corners you probably could omit this transformer with small consequences. It might be well to leave a blank spot on the chassis and first try the unit with the input running directly into G2 of the first 6BE6 then, if it turns out to be necessary you can go ahead and mount the transformer.

The performance of an outboard *if* and detection unit such as this will make a world of difference when try'ng to use a transceiver with a 3 kc passband for CW communication or, for that matter, with any of the cheaper receivers which could use a little better selectivity.

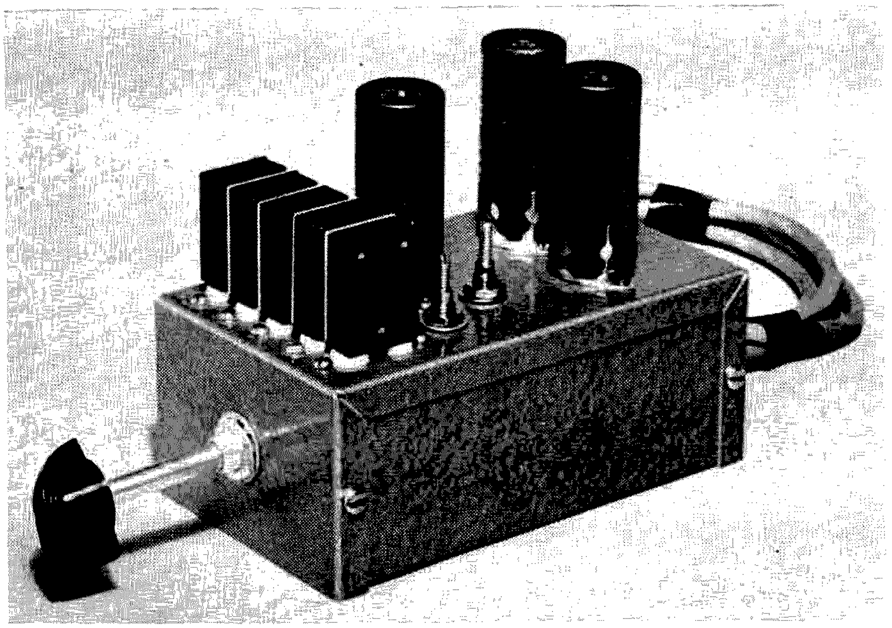
In case you are one who takes your ham work at all seriously it will certainly pay you to construct a unit such as this. You should have no serious problems getting it to operate and it really makes a lot of difference when you need that extra selectivity—and when don't you? As stated earlier, when you use this unit with an audio filter you have just about done all that the home builder can do to solve the interference problem. Besides that, building things like this is fun—try it.

. . . Roanhaus

Parts List

C4. 47 pf negative coefficient capacitor. Sprague 10TCU-N750-Q47.
C7A. 35 pf variable.
C7B. 120 pf silver mica.
C20-23. 100 pf mica.
T1, T2. 455 kc *if* transformers.
T3. 750-1400 μh rf coil. Miller 4413.
T4. 4.5 mc *if* transformer.
T5. 30-69 μh rf coil. Miller 4408.
T6. Power transformer with 130 volt secondary.

Norm Gignac K1QIM/2
Dick Stants WB2CEE
Navy Recruiting Station
P.O. Building
Albany, N.Y.



Put your old preselector to work again

A Crystal Controlled Front End

Have you taken a look lately at that 'once-prized' broadband pre-amplifier you had such high hopes for. . . . You had hoped it would make your receiver 'hottern'-a-firecracker,' but it turned out that you found your receiver was too 'broadband' to handle the added rf with the pre-selector hooked in . . . you had hoped that it would help you pull in the 'DX' on the higher frequencies, but it only makes the noise as well as the signals louder. How would you like to put it back in operation? . . . and without too much difficulty? . . . and with little expense?

This unit to be described here came into existence when it was realized that my own DB-22A, HF 10-20 and DB-23 pre-amplifiers were sitting under the bench . . . and that I had a sizeable investment in this equipment which was going to 'waste.' I'd like to add here that the Crystall-controlled front end described in this article will work equally well with the old-timer DB-22, the R-9er and the Ameco P-CL pre-selectors . . . (pre-selectors and pre-amplifiers meaning the same thing in the text of this article).

So, if you'd like to put into use some of those fine, but very little used pre-selectors, read on. If you're only interested in knowing how it's done . . . that in itself is worth the time to read the article. I'll say this much about the unit described here . . . it perks up the stability of the low-to-medium priced receivers . . . and it's a good way to start copying CW like you'd like to.

Circuit principle

The function for the crystal-controlled front-end (CCFE) rig is basically an rf oscillator, feeding a mixer (hetrodyning all signals down to the 3.5–4.0 mc range), then through a cathode-follower stage to the front end of the receiver.

What it does for the Receiver

It is a known fact, that the stability of the low-cost and medium-priced receivers is 'best' on 80 and 75 meters . . . and is usually 'pretty good' on 40 meters, but when you tune 20 m and especially 15 and 10 m, the stability and sensitivity of the receiver drops off in leaps and bounds. This little gem will make your receiver think all signals, be they on 20, 15 or 10, are really 3,500 kc to 4,000 kc signals . . . this is the principle of the 'tuned if' circuitry. Therefore, you could say the crystal-controlled front-end takes all signals and heterodynes them 'down' to the range of your 80-75 meter-band on the receiver dial. Why the pre-selector, you ask? You need the pre-selector to build up the rf signal coming from the antenna, to a level which would put the

band-selected CCFE into action . . . and too, the pre-selector tends to keep the strength of the signal, although broadband through the pre-selector, at an even keel . . . the preselector acts as the 'tuning' element of the signal.

How do you do it?

Set the pre-selector for the strongest signal, by tuning in the normal fashion. Switch the proper crystal stage into play on the CCFE . . . and tune the signals on the receiver's 80-75 meter band. Therefore, if the preselector were tuned for 15 m CW, and the crystal-controlled front-end crystal was switched to the '15' meter position, the receiver would effectively be receiving 80-75 meter signals . . . e.g. Preselector at 21.100 m, CCFE switched to '15' (with the 17,500 kc crystal in place within the socket), the oscillator, (6AB4), mixer (6AH6), and amplifier (6AB4) would introduce a '3.600 mc' signal to the rf amplifier (or if there is no such stage, to the mixer of the receiver).

The signals entering the receiver's rf amplifier stage (at the antenna input) are stable, selective, and strengthened rf notes which have been through pre-selection, heterodyning and slightly re-amplified. You will find the receiver is operating with greater effectiveness as you "bandspread" your signals across the band. There are no further adjustments to make to the CCFE; there *may* need minor re-tuning of the pre-selector tuning knob should you swing from, say the low end to the top end of the band. In most cases, the RME Pre-Selectors are fairly broadband, and depending on the 'built-in' selectivity of your receiver, may or may not require much attention, other than to make initial band selection and placing the tuning knob in the general portion of the band which you desire to operate.

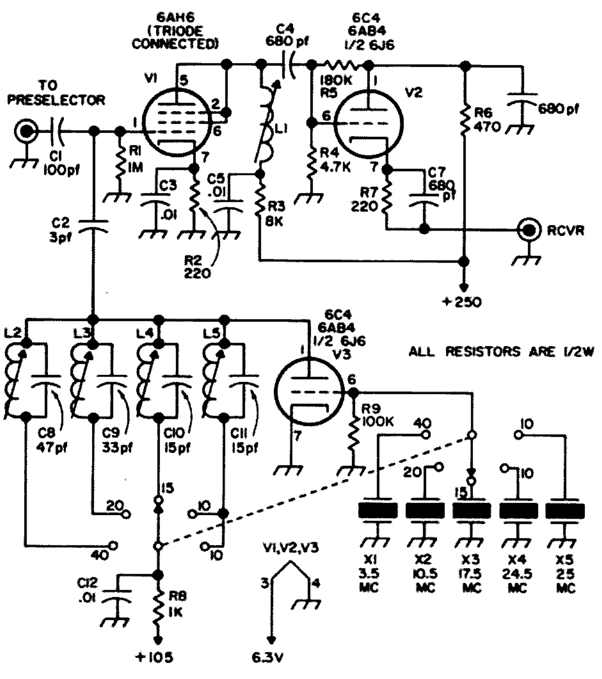


Fig. 1. Schematic of the CCFE.

Construction hints

As the schematic, **Fig. 1** depicts, the layout is fairly simple and normal construction precautions should be observed. Leads are not critical, but as with any component connected with rf oscillations and amplification, as well as mixing, the tradition of keeping the leads short is recommended . . . especially those leads from the crystal sockets to the bandswitch. Current carrying leads should be lead along the chassis and the signal carrying wiring should be traced about ½" above chassis.

Coil L1 is a CTC 1 mc coil with 180 turns removed. Any other coil that will tune to 3.75 mc (the center of the band) will do very well.

The photo shows a general scheme for component layout. The cable uses an octal plug which leads to the receiver's power source feeding the filaments, B+ and common ground and the rf source from the pre-selector. The shaft and crystal-selection switch are left extremely long in this case, because it allows the constructor to place the unit inside the receiver in an appropriately suited location and with either an extension shaft, or as is (depending on location within the receiver) the shaft affords the extension needed to come through the front panel of the receiver (after drilling or punching the appropriate size hole and placing a dial plate behind the knob to indicate the band/crystal selected. If it is desired to leave the unit outside the receiver, the shaft may be hacksawed down to size and would work equally as well . . . this arrangement is a matter of personal choice.

Adjustment is simple. Apply power and tune coils L2 through L5 in sequence for maximum output consistent with reliable starting. A diode detector or dip meter may be used for this. Then peak L1 and you're in business. Nothing more to do, you're receiving.

. . . WB2CEE, K1QIM/2

COIL TABLE

L1. Tunes to 3.75 mc. CTC 1 mc coil with 180 turns removed.

L2. Tunes to 10.5 mc. Miller 4407, 15 to 31 µh.

L3. Tunes to 17.5 mc. Miller 4405, 3 to 7 µh.

L4. Tunes to 24.5 mc. Miller 4404, 1.5 to 3.2 µh.

L5. Tunes to 25 mc. Miller 4404.

All coils have variable iron cores

Ken Sessions K6MVH
4861 Ramona Place
Ontario, California
Drawing by K3SUK

The Key to Peaceful Coexistence

Between 6 meters and channel 2

Probably the most important task a 6-meter man will encounter is that of convincing irate neighbors that channel 2 interference is due to inadequacies in his TV set.

When faced with a TVI problem, the amateur must convey a considerable amount of information to his neighbor in a fairly short time. For this communication to be effective (and understood), the facts must be presented in an orderly, logical sequence. The usual setting for ham-neighbor TVI conferences is not an ideal one for cooperative oral exchange. The relationship between the two individuals is strained at best. The neighbor is bothered by the fact that his program has *already* been disrupted to the point where he finds it necessary to make an appeal (or a demand) to the ham to knock it off. And the amateur knows that within minutes the band may be closing and his DX for the evening will be over.

I have noticed a certain clumsiness in my own oral explanations to neighbors. I skip over important details and neglect thorough explanations of the TV receiver's problems. Consequently, disturbed televiewers have departed without satisfaction, only partially understanding the situation.

It was such a lack of effective communication that prompted me to write a letter explaining my side of the story. The results have been so successful that I feel others might benefit from adopting the same practice.

After writing the letter, I distributed copies to all my close neighbors. Two days later, four high-pass filters were installed in the area, eliminating four TVI problems. When others in adjacent neighborhoods came to complain, I simply gave them a copy of the letter, allowing them to read it on the spot if they desired.

It's nice to be an accepted part of the neighborhood again. We actually get friendly visits from even those 'hard' cases now. And I don't get that queasy feeling in my stomach anymore when I crank up the kw on 50.5 in the evening.

Here is the letter, for those who might want to copy it for their own use:

To my neighbor:

The purpose of this letter is to assist me in determining the extent of television interference occurring in this neighborhood from my amateur radio transmitting equipment. With your cooperation, *all such interference* can be removed and your television viewing need never be disturbed.

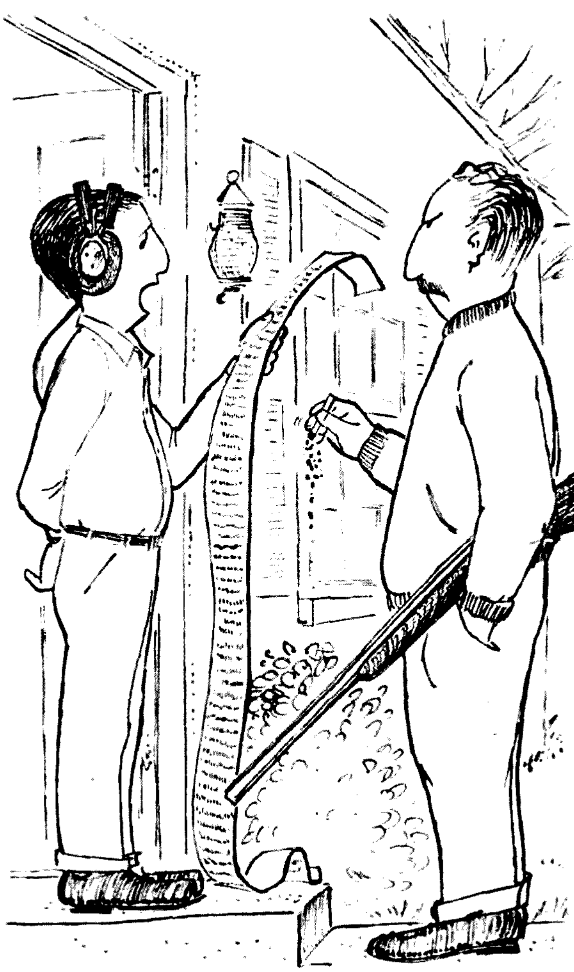
If you are experiencing serious television interference (TVI), you can help me to determine the best method of eliminating the problem.

The radio frequency spectrum has been allocated to commercial broadcasters, private industry, special institutions, and amateur operators. Although this spectrum is crowded, there is room for all. The Federal Communications Commission has assigned me an amateur operator license (K6MVH) and a selected range of frequencies in which to operate. To obtain my license, I was required to pass a very rigid examination to prove my technical ability and knowledge of radio theory. *I am not authorized to transmit on frequencies assigned to television stations.* The FCC has taken great pains to assure that I do not.

The fact that I can be heard on a television receiver does *not* indicate that I am transmitting illegally. It is usually an indication that a television receiver lacks the selectivity required to reject signals near the frequency of the TV channel. The type of TVI you have can help me to determine the cause and to help you effect a cure.

I operate on frequencies between 50 and 51 megacycles, as directed by the FCC. Channel 2 covers a 6-megacycle spread from 54 to 60 megacycles. Thus, interference in your reception of channel 2 is a definite indication of an inadequacy—although by no means incurable—in the television receiver.

Channel 2 interference is the most common



type of TVI a 50-megacycle amateur experiences. No amount of filtering or regulation at the amateur transmitter can reduce this type of interference because it is a receiver problem and the cure can only be effected at the TV set. The degree of interference will determine the prevention measures.

If the picture is affected seriously, or replaced by a series of horizontal bars that vary with the sound of the amateur station's signal, the problem is serious enough to warrant installation of a simple high-pass filter in the television antenna line. This will remove all channel 2 interference in 95% of the cases. (A high-pass filter costs a minimum of 75¢ and not more than $4.00. The price depends upon the degree of filtering required.) High-pass filters are easily installed in minutes. While the FCC has cautioned me against installing filters for neighbors, I will gladly guide you in such installation.

A letter to the FCC will quickly bring you assurance that the installation of filters in TV sets experiencing channel 2 interference is *not* the responsibility of the amateur but a joint responsibility of the set owner and the TV manufacturer. (TV manufacturers are now required to furnish such filters on request for sets manufactured after 1961. This is in recognition of the cause of the fault: the lack of rejection selectivity in TV receivers.) To install a filter, the 300-ohm antenna wire must be cut between the TV tuner and the TV set's antenna terminals. The "antenna terminal" side of the cut wire connects to one side of the filter; the "tuner" side connects to the other. This finishes the operation.

I can furnish soldering equipment, wire cutters, screwdrivers, and technical advice. I will also recommend the type of filter you need and the place where the filters may be obtained.

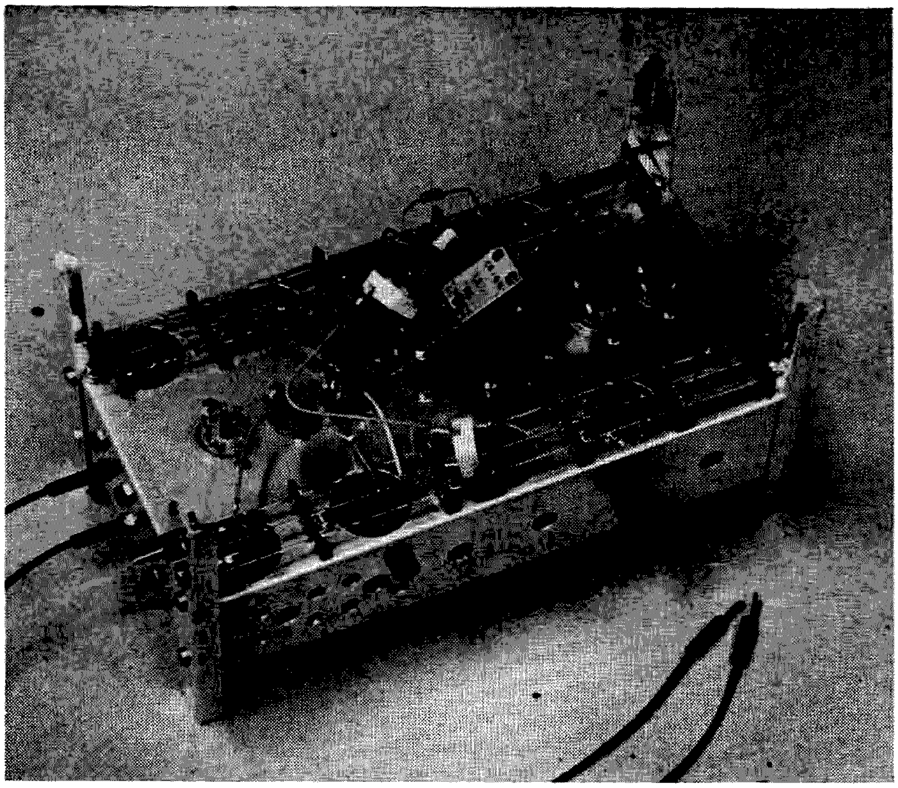
Another type of TVI attributable to the television receiver's inadequacies is the pickup of an amateur's audio signal although the picture may be undisturbed. This type of interference is not restricted to a particular channel, and frequently occurs in hi-fi and stereo systems, radios, and fm receivers. Generally, the cure is very simple—but again, it can only be accomplished at the place where the interference occurs. The principal sources of signal pickup are the ac line and speaker wires. First, make sure your amplifier is well grounded to a good earth ground (such as a cold water pipe). If this doesn't do it, the ac line must be bypassed to the amplifier chassis. This is merely a matter of soldering a .01-microfarad capacitor from each of the 110-volt wires to the chassis at the ac input to the amplifier.

If the interference is on channel 11 or 13, the problem may be attributable to harmonic radiation. If this occurs, I can help it at my transmitter by installing a low-pass filter in my own transmitting antenna line or by taking more extreme measures in shielding. This will not affect channel 2 interference.

Whatever the interference or cause, I want to cooperate with you. There is no reason why you can't enjoy your evening hours with television while I indulge my chosen hobby. Ham radio and TV reception *are* compatible, but only through reasonable interference precautions cooperatively administered. My wife is probably more critical than any neighbor, and she enjoys color TV nightly, watching any channel without interference. I eliminated problems at my own set by installation of a 75¢ filter.

My name is Ken Sessions. I operate a 6-meter amateur radio station at 4861 Ramona Place. Please feel free to stop by at any time for any reason. We can just get acquainted, discuss TVI, or talk about the world crisis. The coffee pot is always on.

. . . K6MVH



Breadboard of the if amplifier in Fig. 2.

James Ashe W2DXH
R.D. 1
Freeville, N.Y.

Breadboarding

Do you breadboard everything you build? Maybe I should have asked, do you breadboard anything you build? I suppose breadboarding each circuit would be too much, but it seems to me that in general most amateur electronics builders do not do as much breadboarding as they should.

I think I ought to mention for the beginners that the term "breadboard" stems from the days when real, actual breadboards, obtained sometimes from the kitchen, were used for building circuits. In a way that seems like a long time ago, but as recently as the late thirties people were still writing up projects built on breadboards. In fact, I remember seeing such projects in the now defunct electronics sections of ***Popular Mechanics*** and ***Popular*** *Science* after WW2!

But enough of that. Why do you breadboard? What is breadboarding, if circuits are no longer built on pieces of wood? And how about stray capacitances, and having the circuits right out in the open? What about shock hazards? These are some of the questions you might ask about breadboarding.

I might begin answering them by giving an example. **Fig. 1** is a schematic of a crystal-coupled *if* circuit, copied out of an amateur publication. This isn't the entire *if* section. It is a single basic circuit unit.

Now let's look at this in a hardheaded, skeptical sort of way, like the farmer who saw a purple cow. The first thing to do is to decide on a plausible explanation of how it works. I'll skip over that point since it will do you good to work it out for yourself and I'm aiming for a different target anyway. The next thing to do is to decide on reasonable values of voltage and current. This is a very good exercise because these operating values are rarely given, and are useful in dealing with a circuit that doesn't work. Besides, it helps clear up some residual doubts about how the circuit works. Now when we look at this schematic we see some interesting things.

Namely, if the supply voltage is 150 volts and the rated class A (from tube handbook) circuit is going down through the tube, then the drop across the load resistor puts the anode voltage at minus 700 volts. We must conclude that the tube is carrying far less than its rated current. Is the resistor ten times too big? This could happen as a result of a misplaced decimal point. If it were 4700 instead of 47,000 ohms, at ten ma, there might be about 50 volts across the resistor and 100 volts across the tube. This certainly seems better.

Secondly, how about those 2200 ohm resistors at cathode and anode of the phase splitter? This triode has the same ratings as the other one. Again, 10 ma thru 2200 ohms gives 22 volts. This drop in each resistor leaves 100 volts for the tube. But wait! How about the grid voltage? If the grid is at ground and the cathode at plus 22 volts, this particular tube is cut off, carrying no current at all. Obviously this triode, also, is carrying a current far different from the handbook listing, unless we can find another possible error. What might it be? Well, anode and cathode resistors have to be equal, and they can't be too large, and the grid-cathode voltage has to suit the anode voltage and current. There's only one way to do it. We have to bring the grid voltage above ground.

If the 10 ma is flowing, and the cathode is at plus 22 volts, the grid has to be at a little lower voltage than that. About one volt should do it. Current to a positive grid? No, not when the grid is negative with respect to the cathode. We want the grid to be at about 20 or 21 volts—the cathode will follow it by the required amount positive because of the fairly large cathode resistor. If we add a resistor—it might have been left out of the drawing—just large enough to pass enough current through the grid-to-ground resistor to bring the grid to the required voltage, it should work.

That would account for it—one incorrect parts value, and a copying error. We might want to change a 47k to a 4.7k resistor and add a 560k resistor.

Now before we go off and celebrate, there is another possibility to consider. Somebody built this circuit and if worked. But we have just decided it can't work, or at least that it can't work very well. How are we going to resolve this? But a good idea to have an answer before going to the time and expense of building the finished product, wouldn't it?

This is where the breadboard comes in. The old practice of building things on breadboards was gradually transmitted to the process of trying things out on breadboards. But what with the natural shapes of components, the convenience of working on a metal sheet, and the fact that chassis seemed to be more available than breadboards, the metal type breadboard came into use. It is still called breadboarding, but I have seen and adopted the term "universal chassis."

So let's suppose you have a universal chassis handy (I'll come back to this later, meanwhile see the photograph). You have a heater voltage transformer and a power supply providing a few reasonable voltages such as 75, 90, 108, 150, and 258, stabilized by voltage regulator tubes, also some instruments and a clear place to work.

So. Those voltage regulator tubes I mentioned. If you use a series dropping resistor, or a tapped resistor, to get the correct voltage, every time the current changes the voltage will change too. Also, while these regulator tubes are not very accurate, they may be better than your meter. And the current the simple breadboard circuits use will rarely exceed the capabilities of a single tube to regulate—20 ma or so.

Now we can start breadboarding the circuit. Look at the universal chassis again. This is the circuit I am writing about, after breadboarding. There are a lot of parts aren't there? This is what the permanent ones do: The posts at the corners enable you to set the chassis with any surface down and expect it to stay that way while you work on it. Supply voltages are brought in through the tip jacks in the chassis, left hand end. Signal voltages go in where required, sometimes through a jack in the front of the chassis, often to a wire projecting out of the circuit, or through a jack in one of the posts. There are some clearly identifiable ground jacks for circuit and particularly and most emphatically for safety reasons. When making connections the ground is made first; when removing wires the ground goes, definitely, last.

The holes across the front of the chassis are for controls. Additional holes are drilled if and where needed. Transformers are mounted by one end or corner, and we try to get along without meters and such in the chassis. In normal usage the tubes or transistors project downwards, out of the way of the work.

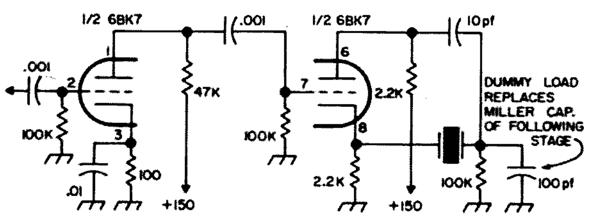


Fig. 1. Original schematic of a crystal-coupled if amplifier. This circuit has a number of problems as discussed in the text.

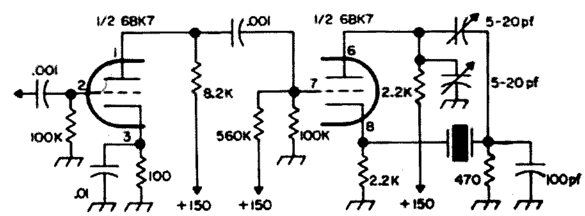


Fig. 2. Revised schematic of the if amplifier.

We work mostly on the upper, flat surface. You can see the tube sockets projecting upwards, some miscellaneous wiring, and two sets of three wires each across the chassis. These wires are the supply lines, permanently connected to labeled jacks at the end of the chassis. I labeled the jacks plus-plus, plus, chassis, minus, heater, and heater. The plus-plus and plus lines go across the side of the chassis away from you, with the center one being well connected to the chassis. One of the three on the side toward you is also connected to the chassis, the other two being a minus and a no-connection. Two lug strips mounted inside the chassis carry the heater voltage, and I run wires for this as needed. When stripping the chassis, I leave the heater wiring in because it rarely needs to be changed.

Now we have things pretty well explained and are ready to start. Having collected the parts we start putting them in. There are two extremes here which you would like to get fairly in between. You aren't trying to build an electronic masterpiece, but on the other hand if things don't go well you might be working on it for quite a while. I try to put parts in neatly with enough room around each one for another and without putting too many into networks floating in the sky (ha!). But I don't let this interfere with getting the circuit finished so I can answer my questions.

So now the thing is put together. I connect it to the power supply—ground lead first! And I turn on the heater voltage only. One minute later I turn on the high voltage and if I have any idea that a particular component might be expected to sizzle, I'm watching it. (smoke test) Usually everything goes well and we are ready to make measurements.

This brings us to a Major Problem. That is, how can you get the most from your time? Which measurement will supply the best answers? If the measurement doesn't tell you anything, you are wasting your time. And the only way to avoid this is to have some idea a) what you should find and b) why you might not find it.

With this in mind we approach the breadboard—which has passed its smoke test—with a good voltmeter. Measurements verify our conclusions about the tube currents being small. But what is the circuit gain? It seems to be about unity! At this point we need to stop and think very clearly because rf measurements tend to be hard to make with simple gear. Now the bigger the signal we put in, the bigger the output will be, and both will be easier to measure than very small signals. But if we put in too large a signal, we will upset the tube biasing, spoiling our results.

Back to the tube manual. The 6BK7 entry doesn't show any plate characteristics but it does say 18 ma per section thru 56 ohms cathode resistor, which will yield a grid to cathode bias of slightly over 1 volt. That means the absolute maximum rf signal on the grid ought not to exceed 2 volts peak to peak. At best we would like to have a signal a tenth of this amplitude, peak to peak. Let's settle for about half. The frequency of the signal is determined by the crystal we are using—let's say we have a 6.9 mc crystal in the socket.

You must make these measurements with something that won't disturb the circuit too much, and a proper rf probe attached to a vacuum tube voltmeter is one way to do it. Another good tool is a Tektronix scope and probe—then you can compare input and output to check for non-linearity. Or go to a lower frequency and use a Heathkit oscilloscope. The important thing is to have an instrument—something that will at least suggest to you what's happening in the circuit.

Well. Now the circuit is assembled—I won't say built because we want to have it around the least possible amount of time. It has passed its smoke test, a gain check shows that something is getting through. We start to measure voltages. The grid of the first triode is negative! The cathode voltage indicates a current of 2.2 ma is flowing, and the anode voltage is about 36 volts. Now why is the grid negative. . . . Having reasoned that out, we see about the gain. With a transconductance of 9300 micromhos we would expect a fairly high gain—we get a result something like 4! Seems we could use more current. So in goes a smaller anode resistor and we see the gain increase, but as we continue in this line we find that the gain does not get up to the figures we might think possible. Well, we won't worry about that—come back to it later.

After disconnecting the signal source we go on to see what the second stage bias voltages are. Well, here's the cathode at 3.4 volts and the anode at 139 volts. That is 135 out of 150 volts across the tube. Seems like there should be more across the resistors. Also the grid voltage is going to tend to overshoot the cathode voltage if the signal is large enough. That's another thing to keep in mind.

Taking a signal voltage measurement at the grid of the second triode, we reduce the generator voltage until we have the same voltage out that we formerly had in—a volt or less, depending on our instruments. This is to avoid overloading the second stage.

Reconnecting the signal generator we make a gain measurement. The gain, expected to be near unity, turns out much poorer than that. Since the tube current is small, it seems that a good move is to increase it. Adding a 560k resistor from plus 150 to the grid brings up the current—now the output signal is better.

Why didn't we start at the second stage and work backwards? In an audio amplifier this would be a good idea, since we could use the finished part to operate a loudspeaker, and we could listen to the results. But this circuit is an rf circuit containing a quite active tube and a crystal whose properties near resonance are very, very abrupt. This way we can put the signal into the relatively tame first stage and if there is any reaction from the second stage back to the first(there is), the circuit will be seeing this in the way most similar to normal operation when finished.

A measurement now shows that there is a much larger signal at the second stage anode than at the cathode. How can this be? The same current is passing through both 2200 ohm resistors, there simply has to be the same signal voltage at both points. But these measurements show otherwise. . . . Ha! This is a reactive circuit. We have different reactances at anode and cathode though the resistances are the same. The reactance is probably capacitive, and there is more of it at the cathode than at the anode—we should probably add a trimmer, anode to ground. We'll come back to that—we go on to the output and think about the 100 pf capacitor which is taking the place of the next triode's input characteristics. What's the reactance of that capacitor at 6.9 mc? About 200 ohms. Then why use a great big grid resistor of 100k? The phase splitter should be able to drive a heavy load. Let's put in a smaller one and see what happens. 47k . . . 15k . . . 8.2k . . . 2.2k . . . how long can this go on? Finally we stop at 470 but this obviously is not the end of the line. The output is down a little, just enough to detect the change. Having gotten some results in this line, we put it off till later.

The sharp tuning is beginning to be a pain . . . well, let's solder in the anode to ground capacitor and see what happens to the gain. Why, it appears that the gain increases as the anode capacitance is increased! The more capacitance from anode to ground, the higher the gain! An the anode and cathode signal voltages are nearly aqual. Now that's an interesting result, and a useful one too. The schematic now looks like Fig. 2.

At this point the apparent circuit gain has increased from about one to around five, the tuning seems to be sharper, and we feel like stopping. I did some things that aren't listed here, mostly checks to get the clearer idea of what was happening. The greatest problem is the signal generator which tunes too fast. Let's see, if I had another universal chassis, I could put together a simple circuit with a cathode follower into a gain control, with good bandspread, about a mil of plate current . . . let's see now. . . . And I leave the subject at this point. It isn't finished. That bandspread signal generator will be needed, and we ought to look into the actual characteristics of that diode pump probe at these frequencies (mine is off to half at 200 mv PP input, reads 0.8 times input at 4 volts PP, etc.) and we should read up on some vacuum tube and rf measurements theory before trying again.

So that's an example of the application of the universal chassis to breadboarding a single circuit. Can you see how much better this is than wrestling with a semifinished product? A good hard look at any circuit can pay big dividends. But human nature and other problems being what they are, the hard look is likely to be deferred if you can't do it fairly easily and efficiently—hence the universal chassis and its associated power supplies.

That seems to introduce the idea quite thoroughly. I think that only one or two points remain. The first is circuit capacitances, to chassis, and to other wiring. Now how large are those capacitances, really? Are they very large compared to the other capacitances you put in yourself? In general, they are not. And in cases where they are you can try to minimize them, or at least allow for their effect.

The other point is safety. Those high voltages, out in the open. Anybody who works with high voltages is going to get bitten. But the frequency with which this happens can be made very close to zero. The first thing you do about this is decide on a sequence for turning things on and off—high voltages last and first, respectively. Then you learn to follow this sequence, invariably—or at least almost invariably. Then you keep in mind that though you remember turning the thing off just now, you are going to act as if it were still hot. And finally, you try not to have such a cluttered and crowded bench that you lose control of what you are doing. I think that to the extent that these precautions are fudged —and they will be fudged—accidents are more likely. But you will learn very quickly, probably have already, that the greater the voltage the more religiously you will follow the safety procedures you have decided upon.

. . . W2DXH

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Noise Considerations in a Preamplifier

Many pages of text have been devoted to the classic subject of noise, but few hams involve themselves with this information. Unfortunately, most noise concepts are explained at an engineering level that is difficult for the amateur to comprehend. Noise in an amplifier is the primary criterion of merit at frequencies above 100 mc. The basics covered by this article should be known by all VHF-UHF enthusiasts and will be useful to every ham.

Tube Noise

The predominant sources of noise in tubes are described briefly as follows:[1]

Shot Noise is caused by random emission of electrons. It is found throughout the useful range of operation and is somewhat greater at high current levels.

Induced grid noise is due to fluctuations in the space charge which induce voltage in the grid circuit. This is a predominant source of noise above 30 megacycles.

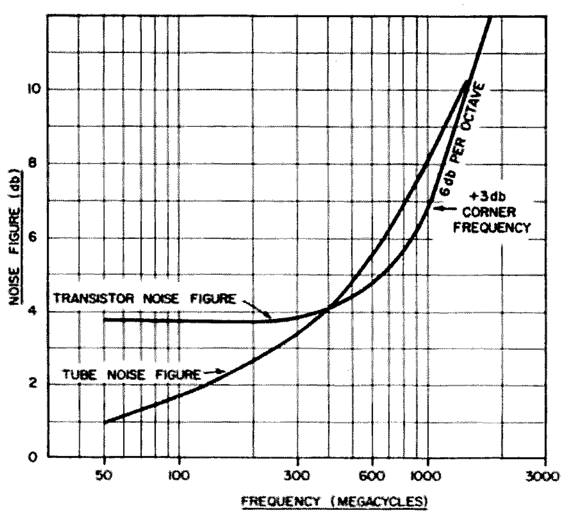

Fig. 1. Typical noise figure vs. frequency for UHF tubes and transistors. Note that curves are intended to show shape and only represent typical transistors and tubes. Modern transistors may have very low noise figures and much higher corner frequencies so that they are superior to tubes for all practical purposes.

Partition noise is caused by the division of current to several positive electrodes. It is this noise which makes tetrodes and pentodes more noisy than triodes.

Gas noise occurs when gas particles in the tube become ionized. Gas noise is not usually a problem above 10 Mc.

Flicker noise is another low frequency effect caused by variations in cathode emission.

The total noise output of a tube increases proportionally to the square root of temperature (°K), the tube resistance, and band width. Mathematically, this is expressed as

$$E_{noise} = \sqrt{4k\ T\ R\ \Delta f}$$

where Enoise is noise voltage output

K is Boltzmann's Constant = 1.372 x 10^{-23} joule/°K

T is the absolute temperature (°K)

R is resistance (ohms)

Δf is the bandwidth

Usually a triode amplifier will have lower noise if it has a high transconductance (Gm). (From the formula, Gm may be considered as $\frac{1}{R}$.) Because several other factors, such as construction, enter into the picture, this generality is not used to show the merit of a tube in the VHF-UHF frequency band. A new term, *noise figure*, is introduced to cover the situation in a more practical manner.

$$NF_1 = \frac{S_i/N_i}{S_o/N_o}$$

In this formula, it is seen that Noise Figure (NF) is a ratio of the *input signal-to-noise ratio* (S_i/N_i) and the *output signal-to-noise ratio* (S_o/N_o). Pretty confusing? Not really, if one considers that a high signal-to-noise ratio is what is most wanted. In an ideal amplifier with no noise, the input signal and noise would be amplified the same amount, and the signal-to-noise ratios would be the same. ($S_i/N_i = S_o/N_o$).

The noise figure would be 1 (0 db not 1 db). Because the amplifier is not noiseless,

1. Ryder, J. D., *Electronic Fundamentals and Applications*, Prentice-Hall Inc., Englewood Cliffs, N.J., 1959, PP 211-213

the output signal-to-noise ratio is always lower than that of the input. Noise figures of amplifiers are therefore always greater than 1. It is convenient to speak of noise figures in terms of decibels (db) because of certain mathematical relationships. The noise figure in decibels is a power relationship equalling 10 $\log_{10}$ NF. A perfect noise figure of 1 is equal to 0 db. Let us now consider adding a preamplifier to a receiving system. Using the information from the last paragraph, we know that the noise will be greater, but the factor of gain also enters the relationship.

$$\text{NF overall} = \text{NF}_2 + \frac{\text{NF}_1 - 1}{G_2}$$

NF_1 = Noise figure of the original system in db.

NF_2 = Noise figure of the preamplifier in db.

G_2 = Power gain of the preamplifier in db.

If $\text{NF}_1 = 11$ db

$\text{NF}_2 = 5$ db

$G_2 = 10$ db

$$\text{NF overall} = 5 + \frac{11-1}{10} = 6 \text{ db}$$

The preamplifier has thus improved the system noise figure by 5 db. It can be seen that the preamplifier will generally improve the system if its noise figure is lower than that of the system and the preamplifier has reasonable gain.

Semiconductor noise

Transistors and semiconductor diodes have noise generated in the junction (S). Random electrons, whether excited by temperature or the flow current, are the sources of this noise. Semiconductor noise depends greatly on the type of junction and the various geometries (shapes) of junction.

Excess noise is the term used for the *low frequency noise* in semiconductors which is inversely proportional to frequency. The graphs showing transistor noise do not include excess noise because low frequencies are not considered.

Shot noise in transistors is approximately the same as that for tubes.

Thermal noise is generated by temperature changes and relates directly to the resistance of the element. The same mathematical relationships hold for semiconductors as for tubes.

Tubes vs. transistors

If curves are available for noise figure and power gain of various tubes and transistors, the amateur would be wise to compare before

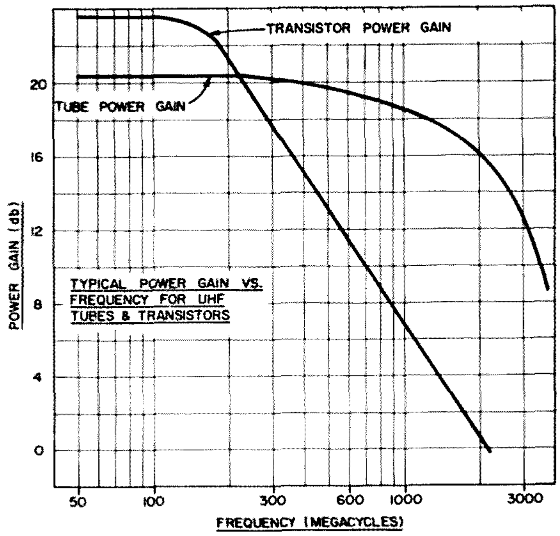

Fig. 2. Typical power gain vs. frequency for UHF tubes and transistors. The same considerations applying to the tubes and transistors in Fig. 1 apply here.

selecting a specific device. Noise figure curves have been sketched in **Fig. 1** for a comparison of shape. Note that the transistor has a minimum noise plateau which extends from below VHF to the transistor's upper frequency limit. This plateau is in the 2 db to 5 db NF region. From the upper limit of the plateau, the noise figure increases rapidly to a maximum slope of 6 db/octave. (An octave is the range in which the frequency doubles.)

Tube noise figure is seen to have a somewhat different curve which *may* cross that of transistor noise figure. Assuming the curves shown were accurate for a particular tube and transistor, it may be seen that this transistor takes preference on the 432 mc band while the tube would be better on 220 mc and 1296.

The gain curve of a transistor (**Fig. 2**) is the inverse of the noise figure curve, dropping sharply from the maximum gain level to zero. Tube power gain declines more gradually which makes the tube useful at frequencies where the transistor is not. A distinct advantage of tubes which is not obvious from these curves or calculations is their comparative ruggedness and resistance to transients.

The question of whether or not to add a preamplifier is best answered by determining just how much performance is gained for the expenditure of time and money. The author feels that nothing is accomplished if the noise figure is compromised. A few simple calculations can tell you if the preamplifier project is worthwhile. Assuming the calculations recommend the project, it should be emphasized that optimum noise figures are achieved only with careful construction. Good Luck!

. . . WB2EGZ

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A Transistor Receiver — VU Style

We, in India, have no manufactured amateur equipment in the market of the quality required for SSB operation. Our Government does not allow import of non-productive machinery, which covers most of our ham gear. Besides most of us do not have necessary finances to buy it off the market either.

Yet our ambitions are high. We want to keep up with guys in the other parts of the world. The only way to do it, is the hard way. We home-brew our equipment. Since economy and performance are the basic considerations, our designs eliminate sophisticated gadgets; we do not bother about good appearance either.

I started thinking about building a receiver when I got a packet of transistors from DL3IR. I was a novice in transistors, as I had hardly seen one before. Being in proud possession of these tiny gadgets I sought simple literature on transistors and their applications. Soon I acquired enough information to kick off.

A review of my ham gear collection revealed a lot of possibilities in the use of components of command receiver BC 455. I stripped one of all the components except the ganged condenser, antenna trimmer, rf coil pack assembly. Relocating the *if* transformers, octal bases, and terminal strips, I kept on tinkering till I built for myself a 12 transistor, plug in coil, ham-band receiver, which is described below.

Circuit description

First is a grounded base rf amplifier using a AF114(T_1). The grounded base application is expected to provide greater stability and a better noise figure, similar to the grounded grid electron tube application. The original coil pack assembly and the plug-in system is adopted for use in this receiver but the coils are rewound and connections suitably altered. The receiver is protected against damage due to reception of strong signals by a reverse biased diode OA72 across the antenna coil. The output is coupled to the base of the mixer stage transistor AF114(T_2). The heterodyne oscillations are fed to the emitter of the same. The components of this stage are particularly chosen for best mixing efficiency. The mixer collector is connected to the *if* transformer where a low impedance tap is provided on the coil to match the crystal filter that follows it.

The oscillator is a colpitts type with a grounded base transistor AF114(T_3). The capacitive tap is provided by 50 pf and 170 pf condensers for connection to the emitter of T_3. Since the band required to be covered is only 350 ke in the 14 mc band, no difficulty is experienced in tracking.

The stability of the oscillator is excellent, but the frequency is very sensitive to supply voltage variations. A 1.5 volt change in the supply voltage varies the oscillator frequency by 10 Kc. This might be a very good feature for use in FM, but presents a great problem in SSB work. I could not lay my hands on a stable supply source hence I decided to run the oscillator exclusively from a string of five 1.5 v torch light cells. Since the drain on the supply is only 1.2 ma, the cells may last their shelf life. I run the receiver off a supply which by no means is stable.

The selection of the intermediate frequency of my receiver was determined by the frequency of the FT 243 type crystals available to me. The intermediate frequency in this case is 7540 kc. Since the *if* is high, there is hardly

any chance of image frequency appearing in the *if* section.

The filter is similar to that described by W3HEA (in *QST* Oct. 1960). X_1 and X_2 are toroid coils, the formers of which have an interesting origin. Commercial transistorized portable receivers come with miniature *if* transformers of the size ½ inch cube. They have ferrite cups which surround the coils. Such cups are salvaged from these transformers. When the base of the cup is carefully sawn off it leaves a ring with a flat wall about ¼ inch diameter. It takes about 25 turns of 36SWG bifilar winding to resonate around 5.5 mc with a parallel condenser of 15 pf. In actual circuit these toroid coils are shunted by trimmers 3-15 pf and tuned to maximum and the best *if* response. The first full section filter is independently terminated by 600 ohm resistance and coupled to the following half section by a 400 ohm resistance. I found that the independent termination of the first section is necessary to get a flat *if* response.

The second section is also terminated by 600 ohm resistance and coupled to the base of the 1st *if* stage. There are a couple of spurious response points in the filter. Since they are around 25 and 50 kc away on the high frequency side, they were allowed to pass on to audio section where they are filtered out.

The *if* strip consists of a 3 stage amplifier using AF114($T_4T_5T_6$) in grounded emitter configuration. The coils are wound on the original *if* forms of BC 455. The coils are grounded in the middle and opposite ends brought to the terminals. This was done, anticipating the requirement of neutralisation. In fact the stages proved to be so stable neutraling was not called for. Each coil is coupled to the next stage base by a 3 turn tap located adjacent to the ground point. The final *if* transformer has an eight turn link which feeds into the emitter of a product detector which is housed in the can itself.

The normal practice is to use a diode detector in the transistor receivers, and I did the same. But this was unsatisfactory as it caused distortion on strong signals. After a lot of worry and tinkering, I hit upon the idea of using a transistor OC170(T_7) without DC potentials as a product detector. It worked surprisingly well. The signal is given to the emitter. The bfo voltage is given to the base. The rf in the collector filtered out and terminated on af volume control. A condenser of high value of .02 μf was used across the potmeter to eliminate high frequency audio signals in the af strip that crept in due to the spurious response of the crystal filter.

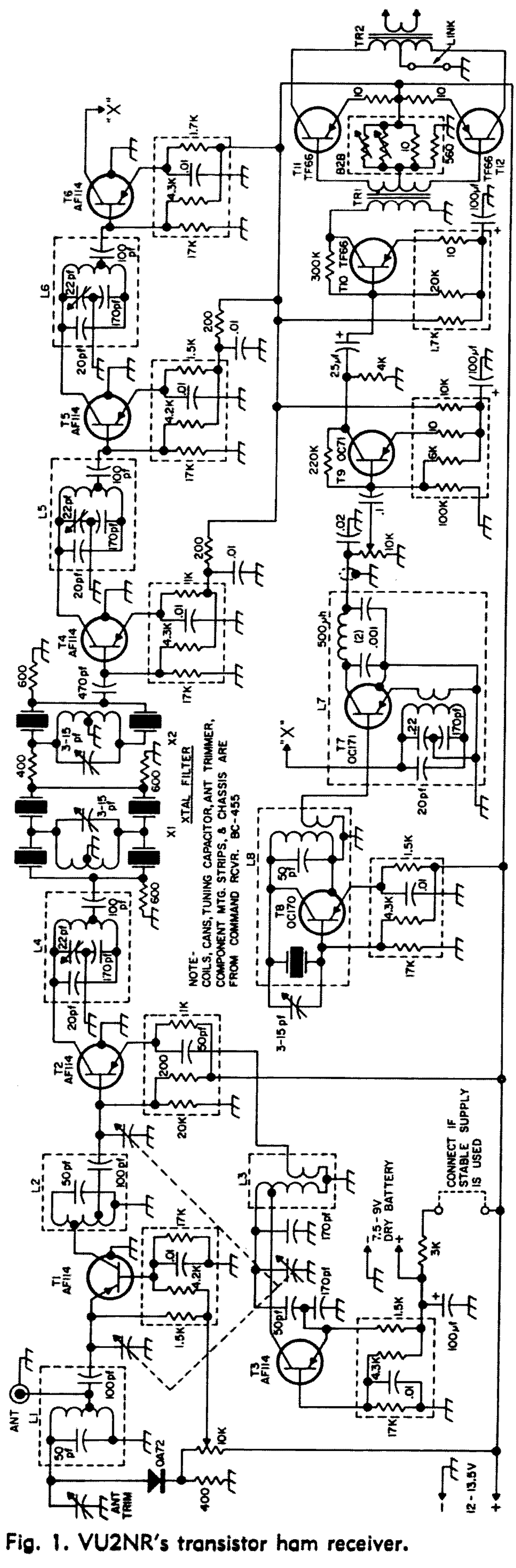

Fig. 1. VU2NR's transistor ham receiver.

Coil Table

Coil	Form dia	Turns No	Gauge of wire	Tap point	Purpose
L_1	Original forms in the coil	10	22	1	Antenna and emitter of T_1
L_2	pack of BC455	10	22	8 1	Collector of T_1 Base of T_2
L_3		10	22	8 1	Collector of T_2 Link to emitter of T_2
L_4, L_5 and L_6	Original if cans of BC455	42	36	18 15	For ground For coupling to next stage.
L_7	—do—	42	36	18 8	For ground turn link to emitter of T_7
L_8	bfo can of BC 455	35	38	3	Link to base of T_7
TR_1 & TR_2	—	Input and output transformers for OC128			

Note: Terminal blocks, coil assemble and several components come out of BC455.

The bfo is crystal controlled. The frequency can be moved slightly by varying the capacitance across the crystal. The coil, the transistor T_8(OC170) and the crystal are all housed inside the original bfo can of the BC455. The crystal holder pins are shortened to allow tight packing in the can. The output is taken through a three turn link to the base of T_7, the product detector.

The af section consists of a stage of audio amplification, the driver and a class B push/pull output. Slight negative feed back is used in the early audio stages. The output stage can deliver an output of 500 mw on a signal of 10 µv. The output stage is protected by deriving its base bias through a low resistance network across supply voltage. Two thermisters type B2B are provided for stabilisation during hot weather. The output transistors T_{11} and T_{12} (TF 66) are housed in a heat sink and clamped to the side of the receiver chassis. This stage idles at 2 ma and goes up to 150-200 ma on signal peaks.

Avc is not provided as it was not considered an essential requirement of a ham receiver. Provision is made for band hopping by changing the coil packs. At the moment a coil pack for 20 meter band is made as there is no activity on other bands around this part of the world.

The receiver is put into operation on the 20 meter band and minor adjustments, as found desirable, are made. Later it is given a check to satisfy a ham in any part of the world. The sensitivity is .7 microvolts for a signal to noise ratio 10 db and gives 50 mw output for 2.5 microvolts of signal input approximately. This level is good enough for a comfortable copy. The selectivity check indicates a 2.1 kc filter response. The response is flat except for a 2 db pop up adjacent to sheer drop on the high frequency side and, with bfo adjusted to 400 cps at 6 db point on filter characteristic, the fidelity is good for SSB operation. The stability can be considered excellent as SSB copy is not lost by knocking the receiver on the table. The appearance, however, is poor, but the owner has no reason to grumble about it.

. . . VU2NR

The Astro Ten

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Here's a ten meter mobile transceiver that is small, efficient, inexpensive and rather easy to build. Spare evenings over a three week period were all it took to get it going. Its one watt power level has been sufficient to enable the authors to hold QSO's around the Philadelphia area. The design approach was to make the rig as simple as possible so that the average ham could get involved with RF transistor circuitry. Let's face it—equipment is all going transistorized and not everything you might want will be available commercially. There's always that certain type of rig you wish you had but nobody's selling, so back to the workbench.

Theory of operation

The transmitter portion (see **Fig. 1**) consists of crystal controlled oscillator Q_1 (a 2N697) driving an amplifier Q_2/Q_3. Either third overtone crystals on ten meters or fundamental crystals from 9500 kc to 9900 kc may be used in the oscillator. The final amplifier approximately matches 50 ohms, so no additional matching network was included. Inexpensive transistors were used in the final and no heat sinks are needed.

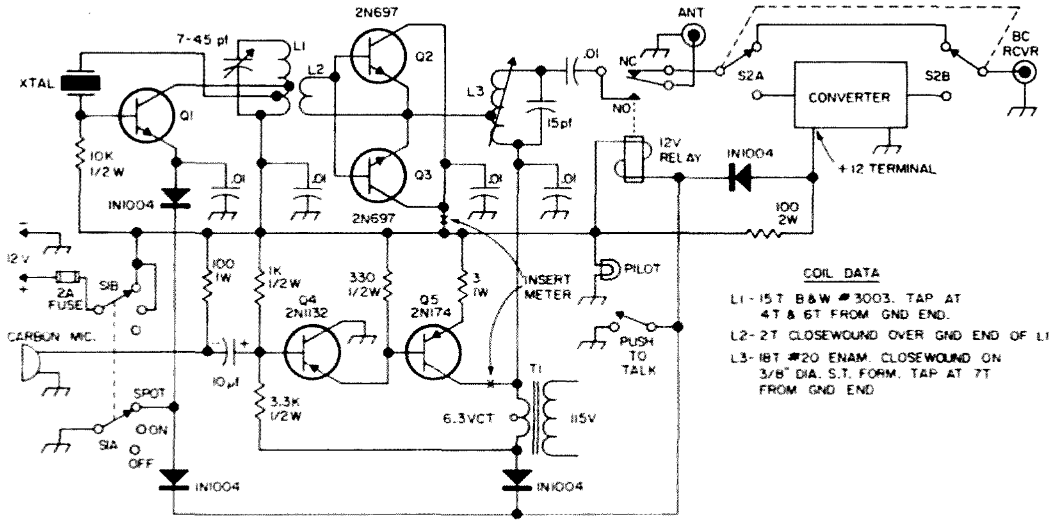
The modulator Q_5 is a straightforward class A "Heising" type using a filament transformer as a modulation transformer. Stage Q_4 serves as a microphone preamp. Emitter negative feedback was included both to improve bias stability and linearity and to prevent accidental burnout of the modulator.

Reception is accomplished by the tried and true method of using a commercial frequency converter with its output on the broadcast band, which then goes to the existing car radio. Power switching for the converter and transmitter circuits is all solid state, a feature found in only the most modern equipment and providing simplicity and reliability at low cost.

Construction

The transmitter is built on a printed circuit board for ease of cutting and drilling and to be able to make soldered ground connections. The preamp is also built on a printed circuit type board but the modulator transistor is mounted on the case for good heat dissipation. Laminated copper printed circuit boards are commonly available from large electronic parts dealers.

The completed circuit boards, modulation

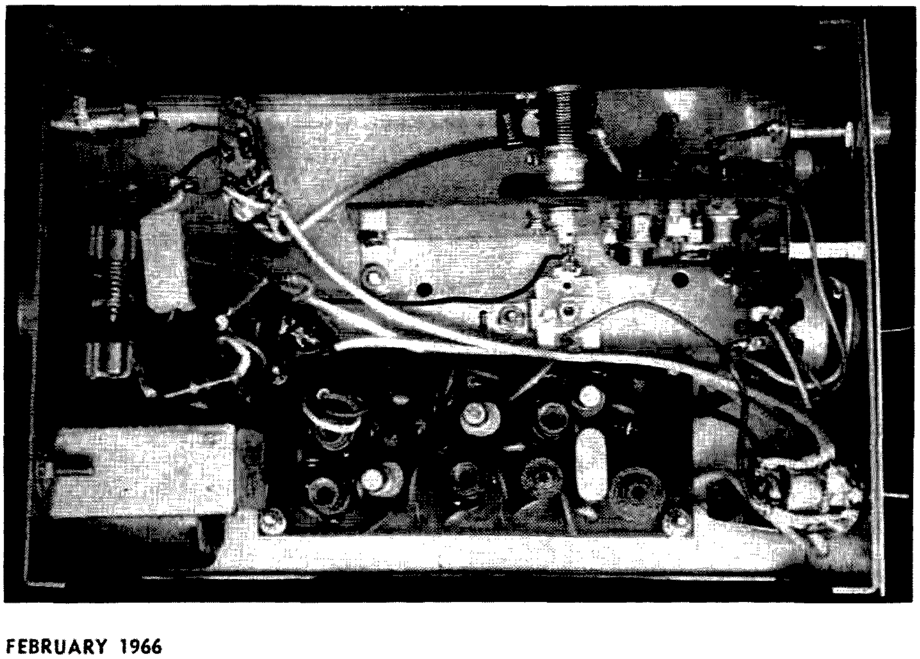


Schematic of the Astro Ten. Q1 is a 2N697. Refer to text for details on construction and circuits.

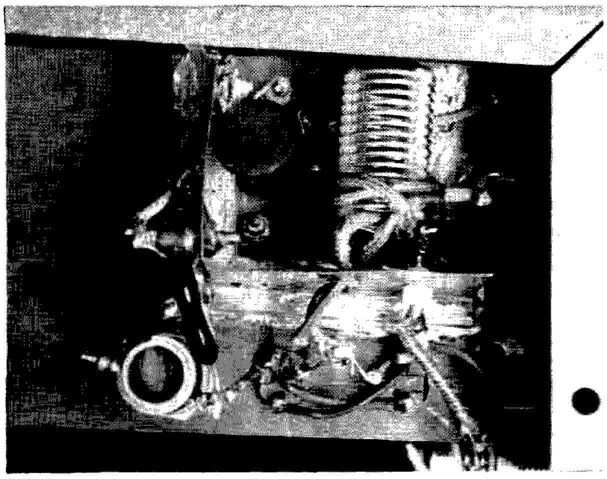
transformer, antenna relay and converter are mounted by means of standoffs and home-made brackets in a 3x5x7 aluminum Minibox. Layout and parts placement may be judged from the photographs. The only critical wiring is on the transmitter board and the guideline here is to keep the leads short. The board is mounted so that Q_1 is close to the crystal socket, which is mounted on the front panel. The oscillator is coupled to the final by a link which feeds through a hole in the copper shield, which is soldered to the printed board. Use solid insulated hookup wire, about #22 for this link.

A word about the modulator transistor: the case is isolated from chassis ground by the mica washer and bushing supplied with the transistor. De-burr the mounting hole and base and emitter lead holes. Make sure there is clearance for these leads. Check continuity from the transistor case to chassis before wiring the modulator to be sure there isn't a short circuit.

The remaining parts were drawn from the junkbox. These include the antenna relay, Motorola antenna connectors, fuse holder, rotary ceramic function selector switch, converter in-out switch and pilot light. Hole sizes and spacings shown are for the author's components and should be revised by the builder if substitutions are made. These are non-critical items and will not affect performance of this rig. Wiring between circuit boards and controls was done with solid insulated hookup wire except for some RF lines. These are shielded, stranded hookup wire, shields grounded at each end. Subminiature coax will also do.



Top view of the Astro Ten. In the lower center is the commercially made converter with the modulator (hard to see) just above it to the left and the transmitter at the upper right.



Bottom view of the transmitter section of the Astro Ten.

Tuneup

With Q_1, Q_2 and Q_3 removed, and a milliammeter in series with the collector of Q_5 (see schematic) apply power and press the transmit button. Q_5 should draw between 200 ma and 350 ma. If it is far outside this range check Q_4 and Q_5. Now interrupt power (go back to receive), replace Q_1, Q_2 and Q_3, apply the milliameter as shown to monitor final collector current and reapply power. Tune the oscillator for maximum final current. The final will not draw current if the oscillator is not working. A receiver serves as a good monitor to check the oscillator. Final current, when the final tank is dipped, and a dummy antenna (50 ohm one watt carbon resistor) is connected should be about 100 ma. Do not let the final current exceed 150 ma for any length of time, or the transistor's dissipation will be exceeded.

Now check operation of the rig across the band by substituting different crystals (obtained from surplus stores). The oscillator tank might have to be returned to cover the full range properly. Once tuned up, the milliameter may be removed and the rig will continue to run reliably without any retuning. The authors monitor output from time to time with a field strength meter (73, April '62, p.9) but have noted no changes. The transmitter board, by the way, is obviously larger than needed. When higher power RF transistors become much cheaper, a higher powered final will fill up the empty space. The modulator, by design, has sufficient reserve power to handle a more powerful final.

Instructions come with the converter, so nothing more need be added. If trouble is experienced here, recheck your wiring. Then there's nothing to do but put it in the car and enjoy it. . . . W3YZC, W3IXL

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Improving RTTY Reception

It's a big thrill to watch your printer pounding out perfect copy from a distant RTTY station—but it is far from thrilling when bursts of interference suddenly cause the copy to look like a cartoonist's idea of profanity! But don't give up. . . . There are several things we can do to improve this situation.

Most RTTY receiving converters convert the incoming FSK to audio tones. These audio tones are then passed through a limiter and then to tuned filters with associated tone detectors. This method of FSK detection is fundamentally the same as FM and exhibits much the same characteristics as FM. Whenever the signal we are trying to copy is stronger than interfering signals, the "capture effect" occurs. The desired signal passes through the limiter and the interference is attenuated. So—to obtain a big reduction in the effects of interference on our RTTY copy, it is only necessary to reduce the interference amplitude to less than that of the signals we want.

There are three points in the average receiving system which can usually be improved significantly. These are:

(1) The *if* amplifier

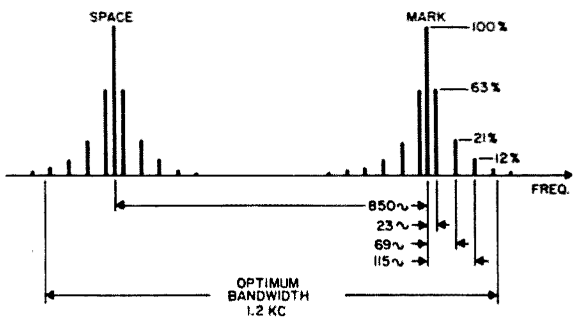


Fig. 1. Spectrum of 850 cps shift FSK signal.

(2) The second detector

(3) The audio ahead of the RTTY converter.

This article will discuss each area. Your particular receiver may be ideal in one or more of these areas. You should be able to judge from the following discussion whether you will benefit from some modifications in your receiving set-up.

IF amplifier considerations

As in any communications system, the bandwidth of the *if* amplifier should be no greater than necessary to pass the spectrum of the signal you want to copy. **Fig. 1** illustrates the spectrum of an FSK signal using 850 cycles shift. Notice that practically all of its energy is contained in a 1200 cps bandwidth. So, we see that 1.2 kc is the optimum *if* bandwidth for amateur RTTY reception.

Many old receivers have *if* bandwidths de-

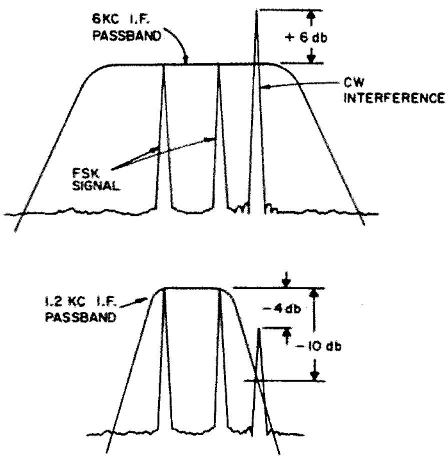


Fig. 2. Improvement in interference by increasing if selectivity.

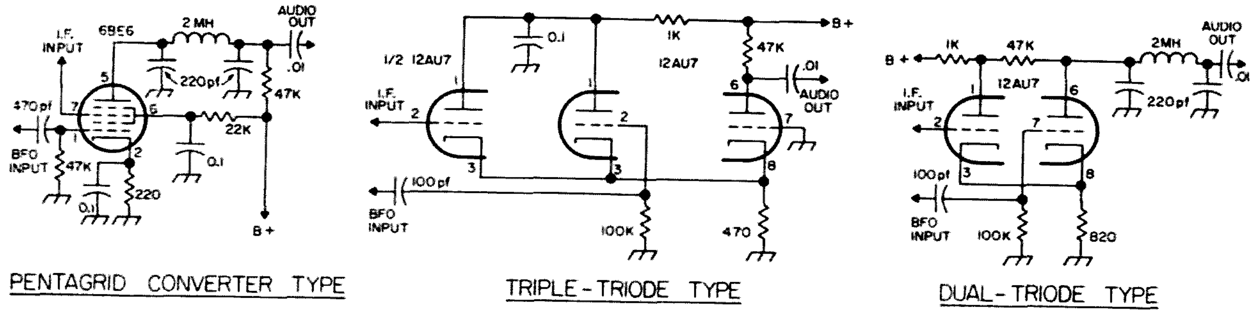


Fig. 3. Product detector circuits that can easily be adapted to most communications receivers.

signed for AM signals 6-10 kc wide. If you are using one of these for RTTY you should definitely take steps to improve the situation. To illustrate how effective using the correct *if* bandwidth is, take a look at **Fig. 2.** Here a receiver designed for AM reception is shown having an *if* bandwidth of about 6 kc at the half power points (−3 db). A CW signal which is 6 db (one S-unit) stronger than our FSK signal comes on about a kilocycle away. Since it is passed on to the RTTY converter, it will capture the limiter and we start printing "Greek"! Now, suppose we can narrow the *if* down to 1.2 kc as shown. The skirts of the filter attenuate the CW signal by 10 db so it is now 4 db weaker at the converter than our FSK signal and our FSK signal has the upper hand. Perfect copy again!

Many modern receivers designed for SSB use have good mechanical or crystal lattice filters with nice, steep skirts and bandwidths of 2 kc or slightly higher. These are excellent for RTTY, and optimum audio filtering (to be described later) is all that is required to put the finishing touches on the receiving system. If you have one of the older receivers which has an excessive *if* bandwidth, there are several possible ways of improving the situation. Obviously, a mechanical or lattice filter of the desired bandwidth can be installed or added by means of an adapter. Many articles have appeared in various magazines describing such modifications for popular receivers.

If your receiver has a conventional crystal filter, some improvement can be obtained if care is taken in adjusting the filter. The selectivity setting and phasing control should be experimented with to find the best settings and these settings marked on the panel for easy resetting. You can easily get the filter adjusted too sharply which chops off part of the FSK spectrum. This will cause the mark and space tones to have unequal amplitudes.

The ubiquitous Q-fiver is also a good solution to the broad receiver problem. The old-standby BC-453 has an ideal pass band for RTTY when the *if* coupling rods are pulled all the way out.

Second detector

At first glance, it would seem that the second detector would not be a fruitful point for improvement. However, if your receiver has a conventional diode detector, a worthwhile gain in RTTY performance can be obtained by changing to a product detector. The reasons are much the same as for using a product detector for SSB. A diode detector produces beat-notes between all signals. Thus, if there are interfering signals coming in with the FSK, the diode detector will generate new frequencies from all of those signals beating together. The result is an increase in noise added to the "honest" noise. This just gives the RTTY converter that much of a harder job. When a product detector is used, it is linear with respect to the signal input and only beats between incoming signals and the BFO appear at its output. So, we give our RTTY converter the cleanest possible signal. If your receiver doesn't have a product detector, you should certainly install one. It will help your SSB and CW reception also. **Fig. 3** shows simple circuits which can be adapted to most receivers. Again, many articles have appeared describing this modification for popular receivers.

Audio filtering

One of the easiest and most effective ways of improving RTTY reception is by the construction of a double band-pass filter to be used ahead of the RTTY converter. If you include a switch to cut the filter in and out, you

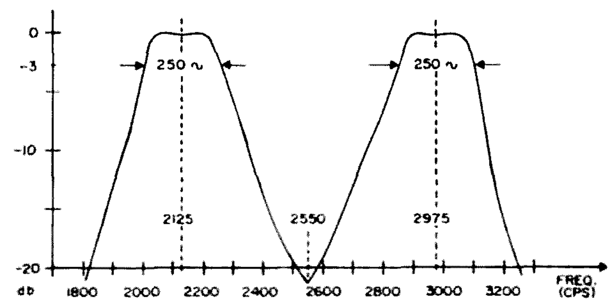


Fig. 4. Response of audio mark-space filter.

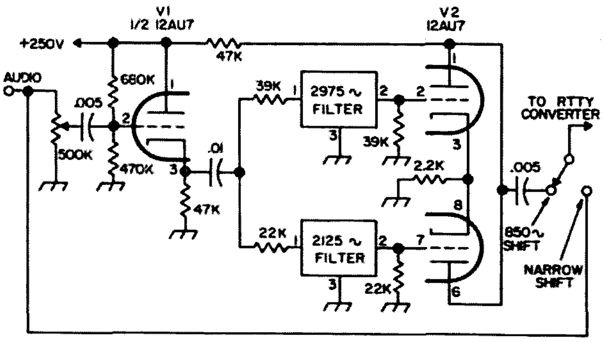


Fig. 5. Schematic for audio mark-space filter.

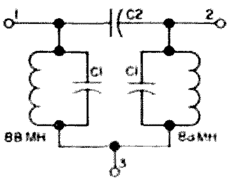
can demonstrate very dramatically how the filter can allow perfect copy even with heavy interference.

Looking back at **Fig. 1** we can see that the FSK energy is concentrated about the mark and space frequencies. The filter to be described has a response curve as shown in **Fig. 4.** Note that the response is down over 20 db halfway between mark and space. Thus, we can have a CW signal at 2500 cps nearly 100 times as strong as our RTTY signal and still get good copy. The half-power bandwidth of each bandpass section is about 250 cps which allows some margin for misadjusted shifts and for a small amount of drift before retuning of the receiver is necessary.

The circuit of the complete filter amplifier is shown in **Fig. 5.** A cathode follower V_1 is used to drive the two bandpass filters in parallel. The two series resistors are essential to provide the correct driving impedance since the filters are modified m-derived types requiring a match at input and output.

They are also terminated with the proper load impedance as shown. V_2 is used as a simple combiner and to provide some gain to overcome the insertion loss of the filter sections. A switch is included to be able to bypass the filter when narrow shift is being copied (and to impress visitors with the gadget!). The input gain control can be permanently set to give unity gain through the filter-amplifier if extra gain is not needed.

Details on building the filters are given in **Figs. 6** and **7.** The inductors are 88 mh surplus telephone loading coils which are widely available. The capacitors used should be paper, mylar, or mica. The ceramic types are



CENTER FREQ.	C_1	C_2	TUNE EACH L-C CIRCUIT TO:	LOAD "R"
2975∿	.03*	.0022	3075∿	39K
2125∿	.06*	.005	2225∿	22K

Fig. 6. Circuit and values for sharp filters.

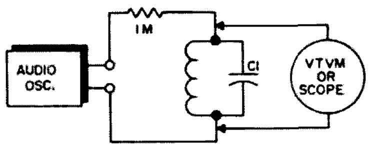


Fig. 7. Test set-up for tuning toroids.

often voltage-sensitive so are not recommended. Notice in **Fig. 6** that each toroid must be peaked at a frequency slightly higher than the filter center frequency. **Fig. 7** shows a test set-up for tuning. A calibrated audio oscillator and a VTVM or scope is needed. If you don't have an audio oscillator, an **LM** or BC 221 frequency meter can be used. Set the meter up on 2000 kc with the crystal calibrator on. You can then obtain accurate audio tones from the headphone jack by detuning the meter dial. For example, if you want 2125 cps, just look in the calibration book for 2002.125 kc and reset the main dial to that reading. The beat note with the crystal will then be 2125 cps.

With the circuit as shown in **Fig. 7,** select a capacitor for C_1, and tune the audio oscillator until you get a peak on the meter or scope. If the audio frequency is not the value desired, you can adjust the circuit by either changing the capacity or removing turns from the toroid. If you wish to remove turns, then use a capacitor that gives a resonant frequency slightly *lower* than shown in **Fig. 6.** Then unwind turns until you hit the specified frequency. If you don't want to fool with unwinding the toroid, then select a capacitor which gives a slightly higher reading. Then shunt it with small capacitors until the right frequency is obtained. Of course, if you're lucky, you may find one capacitor which hits the right frenquency on the nose! Incidentally, small ceramics in the .001 to .003 range are OK for trimming since small variations in these would have negligible effect.

When all four toroids are properly tuned the filter can be assembled. Small pieces of perforated board with "flea clips" are very handy for mounting the components. When installing the filters in the amplifier be sure to provide isolation between input and output to keep down leakage around the filters.

Conclusion

The suggestions in this article should help even the most mediocre RTTY converter to do a top-notch job. They also will help the most sophisticated units to live up to their expectations. Happy printing!

. . . W4EHU

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Quick and Easy Bias Supplies

Need some negative bias voltage for that new rig? Or maybe you're building an auxiliary power supply for one of the popular SSB transceivers such as the Swan, which requires negative-voltage output as well as the positive variety.

Now of course there are dozens of ways to get that negative voltage, ranging from a complete separate power supply with reversed polarity to the popular back-to-back filament-transformer hookup—but hidden in the antiquity of ideas bypassed many years ago are a few which are simpler than any of the methods currently popular.

One, for instance, can give you up to 500 volts negative (from a supply nominally rated at 400 volts positive) at the current drains usually needed for bias (1 to 8 ma), with the addition of only *four* components over those normally used. The largest and most expensive of these components is a small filter choke; the other three are a 400 volt diode and two capacitors!

If you're in need of lower voltages, the same trick can give you up to 9 volts from the filament lines. For tube-and-transistor work, this proves an excellent way of obtaining transistor operating potentials.

The secret of this trick lies in the use of *shunt* rectification rather than the more popular *series* type. **Fig. 1** shows the difference. In A is the normal series rectifier hookup (half wave); the diode passes current to the load on one half-cycle and blocks it on the other. The shunt hookup is shown at B; the diode now shorts the supply to ground on one half-cycle, and looks like an open circuit on the other. When the diode is "open", the current is shunted to the parallel load.

Obviously, shunt rectification cannot be used when the ac generator has low impedance, since on conducting half-cycles the diode is a short to ground and would burn out in short order. Addition of a resistance as shown at C becomes necessary to limit current flow through the diode when it is conducting.

However, since we're dealing with ac rather than dc, there's no need to burn up power in a resistor. An impedance will limit the current flow equally well, and has the advantage that it consumes no power while doing so. The reduction in current flow is accomplished by shifting the phase of the current in relation to the voltage.

This brings us around to the practical shunt-diode rectifier shown in **Fig. 1-D,** consisting of a capacitor in series with a diode, the whole works connected across the ac source, and the dc taken off across the diode. If the end of the diode which goes back to the ac source is grounded, the dc will appear from the hot side to ground.

As in all half-wave rectifiers, the output consists of pulsating dc with a high ripple content. To be useful, it must be filtered.

However, if we try to filter it by connecting a filter capacitor across the diode we find that all of a sudden we have merely a capacitive voltage divider across the ac source, and no usable output. The filter, then, must be of either the choke-input or resistor-input variety.

For relatively low-voltage output, up to about half that available from the ac source, we can use resistor input. The resistor's value should not be less than 100,000 ohms according to the literature, but tests conducted by W5PPE showed 200 volts at 5 ma were available at the output with resistor values as low as 10K. With the same resistor, 10 ma could be drawn at 105 volts. Incidentally, the value

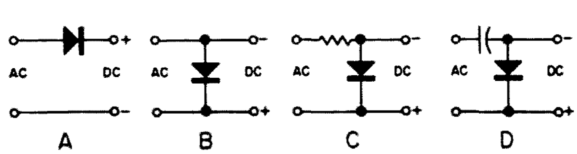
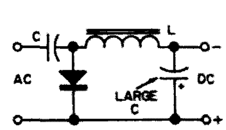
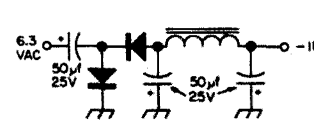


Fig. 1. Series and shunt rectification.





Left. Fig. 2. Step-up by LC *resonance*. Right. Fig. 4. Voltage doubler bias supply.

of the resistor in these tests appeared to be somewhat critical, voltage dropping as the resistance was either increased or decreased in value.

For higher voltages, a choke should be used. **Fig. 2** shows how this works. The choke and the input capacitor form a series-resonant circuit so far as the ac source is concerned, if their values bear the proper relation to each other, while they are a parallel-resonant circuit for the diode and the output. With this hookup, 500 volts could be developed from a 400-0-400 volt transformer with load current running as high as 50 ma!

Speaking of the values for capacitors and chokes in this circuit brings us to another interesting point. The output voltage will be dependent to some degree upon the value of input capacitor C1, even aside from any possible resonance effects. A larger capacitor with its lower impedance will allow more current to flow, resulting in more output voltage. Practical values for C1 range from 0.1 to 1.0 uf, with 0.22 being about as large as will ever be needed for bias supplies not over 150 volts negative.

The filter capacitor should be at least 8 uf, and larger values won't hurt anything. The W5PPE setup used .22 uf at C1 and 40 uf in the filter.

Should a trace of hum or ripple remain, another stage of RC filtering can be added. However, this should seldom if ever be necessary, especially if the output is regulated with a VR tube after the filter.

All of which brings us around to the complete practical circuit, **Fig. 3**. The bias-supply additions are shown enclosed in a dotted box; they can be added to any existing power supply in the 250 to 500 volt output range.

"All this sounds fine," you may be saying about now, "but what about the extra load on one side of my power-supply transformer? Won't that foul things up?"

Strangely enough, according to tests run years ago and written up in "Radiotron Designer's Handbook" (in the power-supply chapter), the extra current drawn from the power transformer is only in the neighborhood of some 100 microamps even when supplying a much higher load current. Diode current is similarly low. The only explanation we can offer for this is that the current is "phased out" by the complex reactance network made up of the transformer secondary, the input capacitor, and the choke.

For the 9-volt supply, the circuit is identical except that the input capacitor C1 goes to the filament line rather than to the high side of

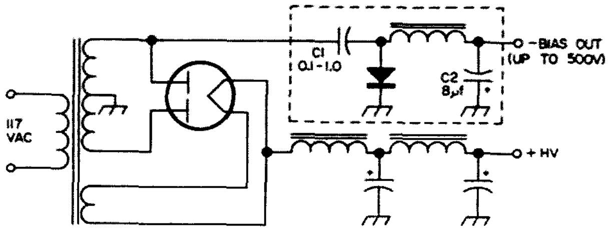


Fig. 3. Bias-supply schematic.

the HV winding. Values of C1 will remain about the same, but the output capacitor can be made much larger since it now must have only a 25 volt or so working rating. The diode, similarly, can be something like a 1N34 as the maximum voltage it will see will be in the neighborhood of 9 volts.

Should 9 volts not be quite enough and 100 volts be too high, the circuit of **Fig. 4** may come in handy. This is a voltage-doubler operating from the filament line, and delivers 18 volts without load. Loading resistors can be put across the output to drop this down to anything desired; at K5JKX the −12 volts for a 6V6 modulator is obtained this way.

The same trick can be used for other purposes than bias supplies. For instance, by reversing polarity of all diodes and capacitors the output becomes positive rather than negative. Now, by putting the circuit of **Fig. 4** on the high-voltage transformer as shown in **Fig. 3** (C1 is now the same value as C2) and using diodes with high enough piv ratings (three 400 volt diodes in series are adequate to handle the normal 350 volt TV special transformer) you have an additional positive power supply which delivers about 1,000 volts no-load. It won't supply much current, so don't expect this to handle a 250 watt final, but it's an ideal way to put together a scope in a hurry.

Some years ago, we rebuilt a surplus ARB-5 loran indicator into a general-purpose scope, using this type of power supply with 0.1 µf, 1600 volt auto-radio buffer capacitors for C1 and C2, and virtually no output filtering. Since our transformer had a separate winding usable for the 5BP1, we left the output negative rather than positive and ran the scope tube's cathode 1,000 volts negative to ground, so that the accelerator could be at a less jolting level. Deflection plates ran about 150 volts positive (direct-coupled to the plates of the deflection amplifiers) and the intensity was much more than adequate.

But for any purpose, the shunt recitifier circuit deserves more attention than it's had in recent years. Keep it in mind next time you need an extra output from an existing supply!

. . . K5JKX

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A Word about Crystals

It's well known that crystals supply probably the cheapest and easiest method of fairly accurate (and stable) oscillator control. Most of us have used them as transmitter control at one time or another. And most of the better high frequency receivers use crystals extensively as local oscillator control.

But how many of the hams reading this have fallen into the same questionable habit as I—trusting their crystals. I'm not implying that crystals aren't stable. I am saying that one cannot really trust the markings on the can. I've known for a long time that one could "warp" a crystal oscillator simply by putting a trimmer across the crystal and adjusting for the desired frequency. But somehow the fact that crystals are not to be trusted never struck me full force until the other day.

The VHF contest was on and the band was open—and I was rock-bound. Needless to say the two frequencies from which I could choose were the two most useless during a band opening—50.35 and 50.4 mc. Then I suddenly realized that both crystals had been picked from a batch and were marked with the same frequency, 8408.182 kc. Now a quick multiplication by six yields 50.449092 mc. Obviously neither of the two crystals I had picked were very accurate. Of course the capacitance in the feedback network of the transmitter could be warping them, but both should be warped about equally.

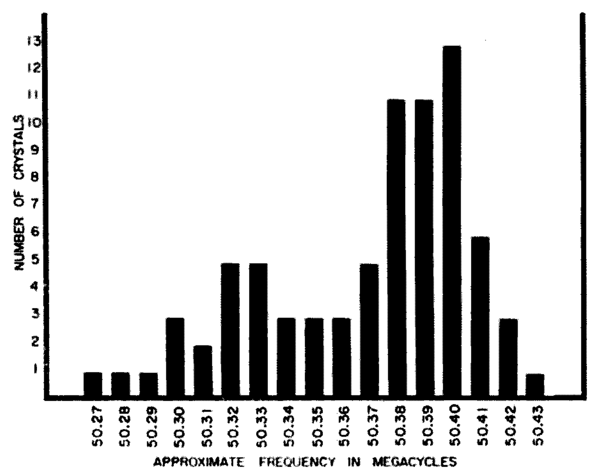
I had a box of these crystals and decided to check each one. My frequency determining setup leaves a lot to be desired, but the relative frequency of each crystal was important for this determination, not the absolute frequency. I used my 6 meter receiver setup (International converter into a BC-455) to monitor the 6 meter signal from the oscillator-multiplier chain of my transmitter.

These crystals are military surplus units in the HC-6/U package, and with a string of numbers like 8408.182 I figured that all would fall within a kilocycle or so after multiplication. But let me show you the figures.

After testing the lot I was able to set myself up with a series of crystals which I marked in 10 kc increments continuously from 50.27 mc to 50.43 mc. In all I checked 77 crystals over that range. The total results are presented as an histogram.

If you, like I, hadn't been convinced before, perhaps these figures will help you. Perhaps the lot of crystals which I happened to have are typical, but had they been near the band edge, and had I put them on without checking I would have been outside the band. Just take a second thought before you blithely slip that crystal in the socket and call CQ.

. . . KØJXO



Frequency distribution (note to statisticians: a very rare bird, this frequency distribution of frequencies) of a number of crystals marked 8408.12 mc by the time they got to 6 meters.

Ed. note: The distribution of the curve hints that the oscillator circuit KØJXO used presented an excessive capacitance to the crystal. However, another circuit would likely produce similar results except that the values would cluster around a different frequency.

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The Design of Parabolic Reflectors

For serious amateur moonbounce experimental work, one must have an antenna that provides a very narrow beamwidth plus adequate gain. The ultimate array for the EME circuit on frequencies of 70 cm or above is the parabolic. With an aperture of just 10-15 wavelengths at the operating frequency, a beamwidth of 4° or better can be readily achieved. Below 70 cm the size of the parabolic required to allow its capabilities to be fully employed is the limiting factor for the average amateur.

Unless you're fortunate enough to come across a "dish" that has been scrapped by a radar station in the junkyard, you'll more than likely have to roll your own. The following will provide you with the info that you need to do just that—design and construct your own parabolic reflector.

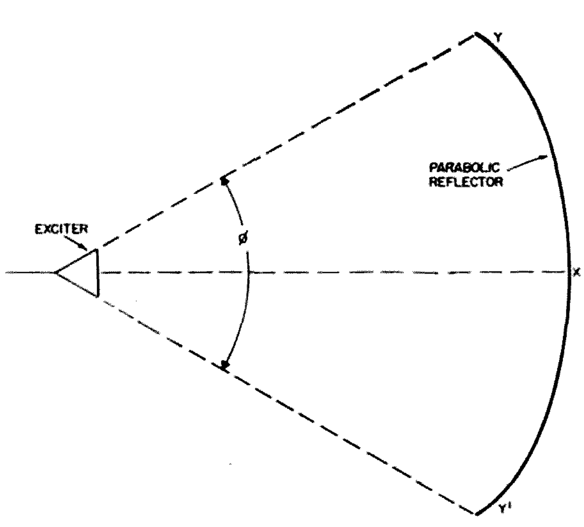


Fig. 1. Feeding a parabolic reflector.

First of all, let's get some facts straight about the parabolic. The parabolic does *not* follow the curve of a circle as so many believe. We can easily confirm this by comparing the equation for a circle to that of a parabolic curve. The equation for the former is $F^2=Z^2+Y^2$ while the parabolic follows the equation $Y^2=4FZ$ (where Y and Z are rectangular coordinates and F is the focal distance). Granted, when viewing the cross-section of a small parabolic one could not detect much difference, if any, between it and the curve of a circle with the human eye. It is only on larger parabolics that the difference is readily apparent.

The focal length for a given parabolic is a constant; it does *not* vary with frequency. Concerning the actual parabolic contour when designing the array, the focal length should be selected to fit the primary feed pattern. Short focal lengths are used with the less directive feed systems while the longer focal lengths are employed with the more directive feed systems to obtain the most efficient aperture illumination.

Depending on how directive the feed system is, the focal length will generally be in the area of .3 to .6 the diameter of the dish D^2. The formula for finding the focal length and a given parabolic is: $\text{F.L.} = \frac{D^2\ (\text{ft.})}{16d\ (\text{ft.})}$ where D is the diameter of the dish and d is

its depth. This formula will be most useful as a check on calculations after the parabolic curve has been calculated.

The parabolic reflector can be excited in various manners. The most commonly used feed systems in amateur circles is the dipole; either the asymmetrical or slot-disc version (the reader is referred to "Pulse: A Practical Technique for Amateur Microwave Work," April, 1963, *QST* for details on a typical slot-disc dipole feed system). Of course, waveguide can also be used to excite the parabolic but it has the disadvantage of being bulky and difficult to work with. If you are interested in a waveguide system, you might refer to K5JKX's article in April, 1964 73 Magazine entitled "Waveguide Simplified." It should supply you with a lot of useful and interesting info on the topic.

The antenna feed must be placed at a point from which all reflected waves from the parabolic will be parallel. The center of the feed is placed in the reflector so that it is an integral number of half-wavelengths from the vertex and as near as possible to the focal length to obtain maximum gain. The antenna pattern of the feed is such that at the edges of the dish, the feed radiation is 10 db (10 times) down from the radiation at the center of the dish. (See Fig. 1).

The energy at points Y and Y should be 10 db lower than at point X. Thus, the feed antenna should have a radiation pattern which would ideally look as in **Fig. 2.**

Therefore, a "shallower" dish will have a longer focus and the feed will be farther from the parabolic reflector.

The parabolic reflector can be constructed of solid or perforated material but the latter has some distinct advantages. Perforated material is much easier to work with and it also reduces the over-all wind resistance of the array. For instance, a 10 foot dish would exhibit the following wind force characteristics:

Wind Force (lbs.) (Solid)	Wind Force (lbs.) (Mesh)	Wind Velocity (MPH)
32	24	10
130	95	20
300	220	30
510	380	40
700	600	50

Of course, a solid plate would make a better reflector but if the perforations are kept small the mesh will not have any noticeable effect on performance. As a rule of thumb, keep the perforations less than 1/20 wavelength in size at the operating frequency.

The reflector material should be constructed from shiny copper or aluminum which has been protected in some way from corrosion.

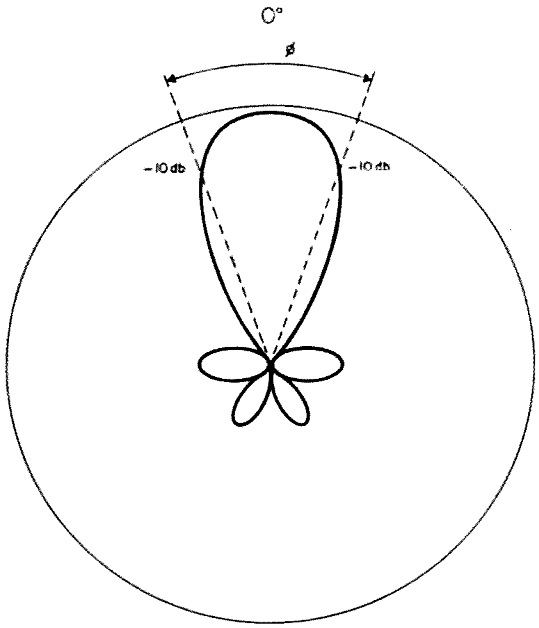


Fig. 2. Radiation pattern of a parabolic dish (paraboloid).

Metals other than these are not recommended for moonbounce because of their heavy losses. Copper would be the best bet for the reflector material since it can be soldered to. This would make construction less difficult and it would also improve the mechanical stability of the array. Mechanical strength is one of the most important factors to consider when designing and constructing an array of this type; it can not be over-emphasized.

Now, for an illustration of how the formulas are used let's calculate some values for a 10 foot dish. The surface of the parabolic will naturally follow the equation $Y^2=4FZ$. The origin of the coordinates is at the vertex of the parabola, and Z lies along the axis (see Fig. 3). The primary feed is of course placed at the focal point.

Suppose we select a focal length of 4 feet for this particular dish. Y is equal to one-half the diameter of the parabolic (5 feet in this case). Z_r, corresponding to the points on the outside of the parabolic curve, is derived by substitution from the equation. Therefore, we have: $Y^2=4FZ_r$' $5^2=4.4Z_r$; $Z_r=\frac{25}{16}$ or 1.56 feet. This is the depth of the parabolic reflector. The other corresponding points along the reflector are found employing the same procedure.

Now, for a check on our calculations, let's see if our Depth (Z_r) corresponds with the formula focal length $=\frac{D^2}{16d}$. Substituting the known values, we have: $4= 100 \div 24.96$ or $4=4.007$ (close enough!).

By plotting several Z values on a large sheet of graph paper, one can obtain an accurate parabolic curve. These values can then be scaled to full size on heavy paper or cardboard. This can then serve as a plan for constructing plywood formers which are used to shape the actual parabolic by securing the reflector material to it. It is best to make one-half of the parabolic at a time and then join the two sections at the hub after they are covered.

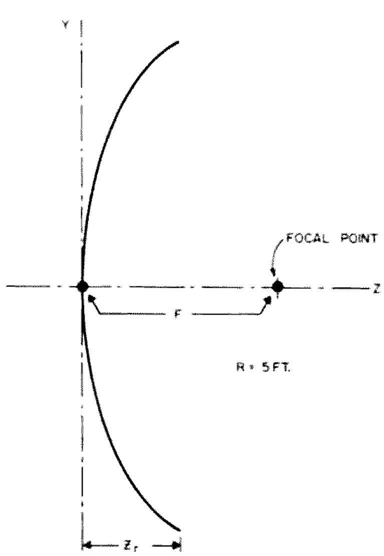


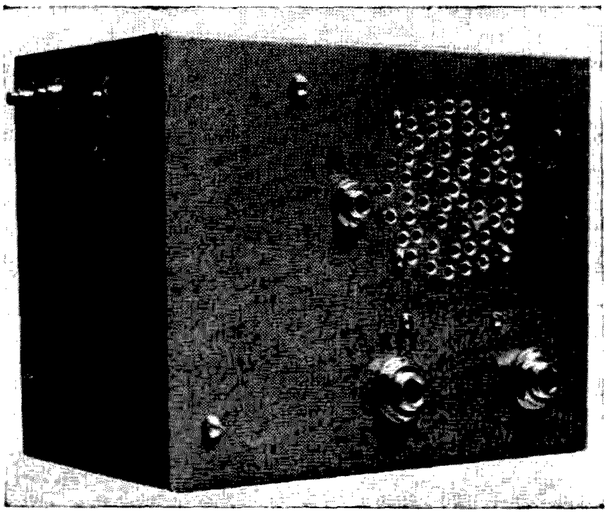
Fig. 3. Focal point of the parabolic reflector.

The gain of a parabolic can be computed from formula but it is complex and will not be discussed here. But the following chart should give you a good idea of what to expect gain wise from a parabolic.

Dish Diameter (Feet)	Gain in db over dipole Frequency (Mcs.) 144	432	1296	2300	10,000
5	5	14	23	28	42
10	11	21	29	34	48
20	18	27	36	40	54
30	21	31	39	44	58
50	25	35	43	48	62

Values given are approximate and will vary some depending on design considerations and mechanical imperfections. In regards to the latter, the error should not exceed 1/16 of a wavelength at the operating frequency.

The paraboloid is the most efficient antenna that the amateur can use for serious moonbounce work in the microwaves. It is an extremely narrow-band and high gain array when designed and constructed carefully. Mechanical strength is of utmost importance because of the parabolic's high wind resistance. With the present state of art in the micro wave region, it can make the difficult EME circuit much more feasible for today's advanced amateur. . . . K3PBY



John Sury W5JSN
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Transistorized CW Adapter

Use your SB-33 or 34 on code

Do you want to get on CW with your SBE-33's or 34's or some of the other types of SSB transceivers? Try this easy way with a built in monitor which should not cost over $10.00. Some amateurs with a well stocked junk box will get off with less. This could be a way to improve your proficiency on CW if you have a keyless rig like the author's. By using the adapter with a good suppressed carrier rig like the SBE's, the end result is A-1. On the air checks were made with Dick Scott WA5HPZ. His remarks were, "It is clean and sure sounds good." He has an SBE-33.

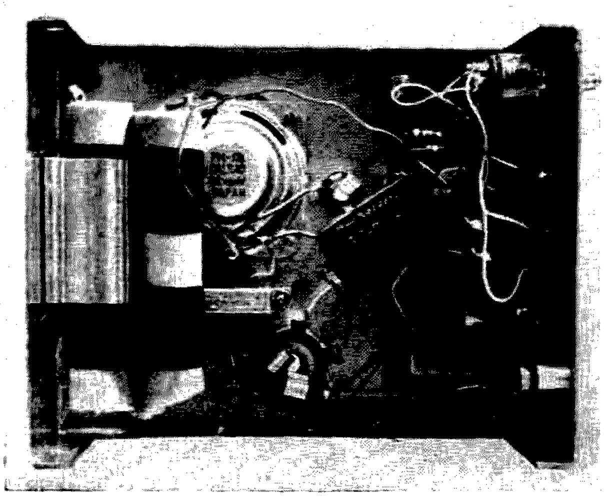
Oscillator

The heart of the adapter is a phase-shift oscillator that produces a pure sine wave with very low harmonic content. The oscillator is keyed at the emitter of the transistor. Resistors R4 and R5 or capacitors C1, C2, and C3 can be varied to change the frequency. Since it is a simpler task, less expensive and space saving to vary the resistors, this is the way the author chose to vary the frequency. It would be very nice to have dual pots of 5K each, but since one was not available separate 5K pots were used. This type of oscillator circuit is more difficult to oscillate. To obtain a good clean sine wave and good sustained oscillation a high gain transistor such as the 2N527 must be used. The reason for using a high gain transistor is because the losses incurred in the network are high. A 2N107 was tried without success.

Amplifier

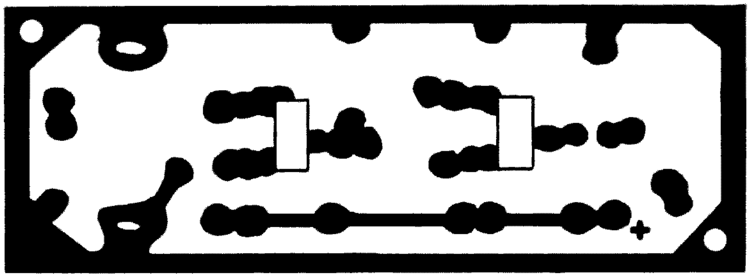
The amplifier is a straight forward medium gain two stage RC coupled amplifier. Here two 2N107's will do very nicely, although a lower noise type is more desirable. The collector of the last stage is coupled to two transformers, one for coupling to the mic input of the transceiver and the other to the speaker and/or headphone output for the monitor.

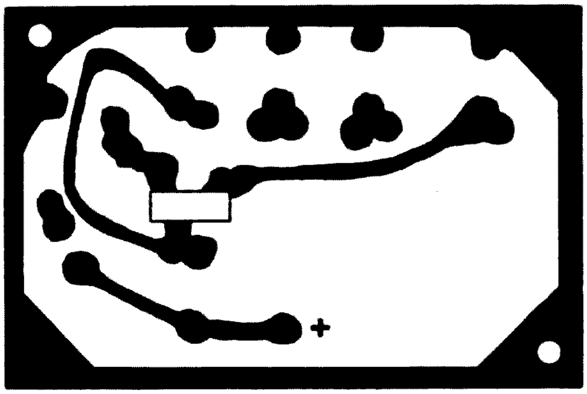
Power requirements for both the oscillator and amplifier is 12 volts at 4 ma. A 12 volt battery is used in the unit so it can be used also for CW practice. Power may be obtained from the transceiver if desired.



Inside view of the CW adapter.

Fig. 2. Right: Layout of the printed circuit board for the amplifier. Below right: Layout for the oscillator board.





In the construction of the adapter the printed circuit board patterns may be used. These are full size. A BUD CU-2105-A (5"L 4"W 3"H) was used to house the adapter. It is not too large and it allowed enough space to install the printed circuit boards, jacks, speakers, speaker transformer, battery, and a DPST switch. The switch operates the push to talk as well as applying power to the oscillator and amplifier. The key jack has to be insulated from the mini-box, or a 3 connector type must be used. The key break is between R1 4.7K resistor and B plus. When the CW key is open there is no B plus applied to the emitter of Q1.

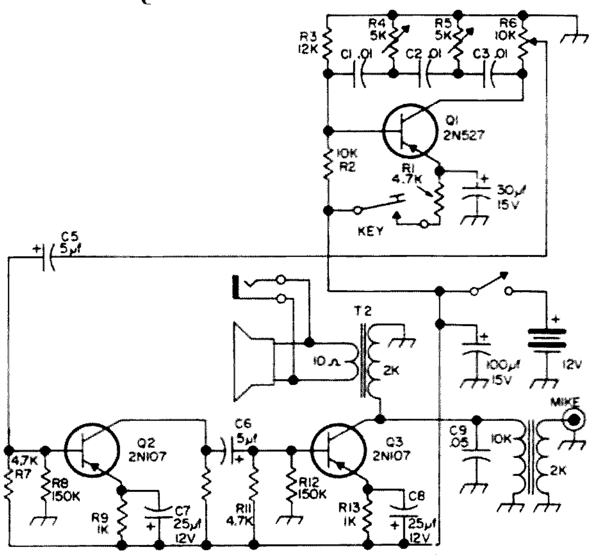


Fig. 1. Schematic of the CW adapter for the SB-33.

Adjusting the adapter is fairly simple. Adjust R4 and R5 for the best tone, or use 3.3K resistors to obtain approximately 1800 cps. Feed your SBE into a dummy load and load up on your favorite band. Set the mic gain in the same position that is used with the microphone. Turn R6 to the lowest output. Turn on the adapter, and key the oscillator; adjust R6 to a level no higher than that obtained with the microphone. The monitor output level on the earphone should be comfortable. The speaker output will be low if a speaker is used. If it is preferable to use the speaker, adjust R6 for desirable level and reduce the gain of the mic input on the transceiver.

Try the "See Dubya" adapter and listen for dah dit dah dit, dah dah dit dah, dit dah dah, dit dit dit dit dit, dit dah dah dah, dit dit dit, dah dit. . . . W5JSN

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Give and Take

International radio conferences introduced amateurs to a new interpretation of the old axiom "you must give and take to get along in this world." From the first to the last, the pattern appears the same: amateur radio can do the giving; foreign nations will do the taking.

The famous Franco-American QSO of November 1923 won for American hamdom the harmonically related bands. Things looked great: 500 kcs on 80 meters, 1000 on 40, and 2000 on 20. But they didn't last. Four and a half years later the power of the first international conference struck. Suffering radical changes, the bands then became worldwide.

Along with the band changes went the right of each nation to control amateur radio within its bounds. Granting of this control really hurt. Many a scar lies unhealed today due to a local change that affected hamdom all over the world. Will conditions get better? Will conditions get worse? Look at the results of each of the five conferences held to date. Can you find any encouragement that amateur radio will fare better at the sixth now hovering somewhere in the near future?

Meters	Remarks
150–200	Spark, CW, and Modulation
75– 80	
40– 43	
20– 22	
4– 5	

The original harmonically related bands assigned by the U.S. Government to American amateurs July 24, 1924.

Washington, D.C. October 4-November 25, 1927.

With shortwaves carrying radio signals to all parts of the world, nations needed to allocate the radio spectrum to prevent one country's radio services from interfering with another's. Regulations of the 1912 London Convention no longer sufficed. To tackle this job, several hundred people from fifty-two countries met in Washington, D.C., October 4, 1927. Within the power of this International Radiotelegraph Conference rested the fate of the amateur bands.

American amateurs looked forward to the meeting. Tired of trying to work DX on bands slightly above or below their own, they hoped for international segments that would put ham activity the world over in the same spots. The United States backed the amateurs 100%. At the conference the American delegates suggested agreement to the current American harmonically-related bands, and cited the value of amateur radio to win the countries over. *It didn't work!* Except for Australia, Canada and New Zealand, amateur radio found few friends. Most countries knew little about it and cared even less.

Shocked that the many important radio contributions by amateurs meant so little in foreign lands, hamdom watched the battle lines form. The fight lasted several weeks. Right from the start England agreed to harmonically-related wavelengths but wanted the bandwidths limited to around 100 kc. France held

Table I.

(a) The American amateur bands in effect when the international Radiotelegraph conference met in Washington in 1927.

(b) The international amateur bands set by the Washington international conference and made effective worldwide on January 1, 1929.

(a) Kilocycles	(b) Kilocycles
1500–2000	1715–2000
3500–4000	3500–4000
7000–8000	7000–7300
14,000–16,000	14,000–14,400
28,000–30,000	28,000–30,000
56,000–64,000	56,000–60,000
400,000–401,000	

out for no message handling; she wanted amateur radio limited to experiments only. Back and forth the battle raged. One moment hope; the next, despair. Only thirty days before the Federal Radio Commission issued hamdom their latest bands; now American hams stood to lose nearly everything practically overnight.

Slowly out of the turmoil 150 to 175 meters emerged for the top band. But the biggest battle lay ahead—shortwaves. Under the American plan the whole bandwidth of a higher frequency band lay in harmonic relationship to the next lower one: 3500-4000 kc doubled all the way from 7000-8000, and quadrupled throughout from 14,000-16,000. Canada, England and Germany balked. Such wide bandwidths interfered with point-to-point assignments in their countries and all refused to move a station.

At this point Italy swung to the side of the amateurs and suggested *variable* bandwidths for the bands. Opposition showed no interest. Recognizing a ray of hope in Italy's recommendation, the United States bought the Italian plan and at the same time suggested consideration of each band separately. It worked! With little difficulty the countries established 3500-4000 kc for the 80 meter band. Now the representatives girded for the real trouble spot—forty meters.

Starting at 7000 kc, the delegates worked upward. At 7200 the first road block cropped up: a German station operated there and the delegates refused to move it. Discussions stymied. To keep things moving, the United States suggested dropping 40 meters for awhile and moving on to 20. The others agreed. When it became evident that 400 kc represented the full spread possible for the 20-meter band, the countries finalized on 14,000 to 14,400 kc. Only forty meters remained. Now a change of heart by Germany removed their station and the 40-meter band moved up to 7225 kc. At this point England consented to move a few and Canada followed suit. Their moves released another 75 kilocycles letting the 40-meter band spread from 7000 to 7300 kc. Beyond that no one would budge.

The Conference adjourned November 25, 1927, after setting January 1, 1929 for the effective date of the agreements and designating Madrid, Spain, as the host city for a second international radio-telegraph conference. As a result of the eight-week struggle: amateur radio obtained international recognition, hams got worldwide frequencies including the 10-meter band, and our present "Q" signals emerged. Each nation reserved the right to fix the power of amateur stations, and to permit or prohibit hams as it desired. *All countries could withhold any or all bands from the hams.* International amateur message traffic could not occur unless special arrangements existed between the nations involved. And, amateurs received identifying prefixes for their calls. Table I compares the international bands with the then current American bands.

Madrid Spain. September 5-December 9, 1932.

Recovering from the shock over loss of big chunks of their favorite DX bands at the Washington conference—1600 kilocycles on 20 meters and 700 on 40—hams naturally cast wary eyes on the Madrid conference scheduled five years away. What, they wondered, would they lose next time? As they waited and fretted, the Federal Radio Commission opened the 10-meter band March 7, 1928, and at the same time changed the phone bands:

1715—2000 kc
3500—3550 kc
56,000—64,000 kc

August 3, 1928, brought television and picture transmission to the 160-meter and 5-meter bands. Two months later (October 1st) prefixes joined our calls: "W" for the mainland; "K" for territories and possessions. On January 1, 1929, America along with the other nations swung over to the international ham bands. However, in addition, the United States still retained the ¾-meter experimental wavelength (400,000-401,000 kc) for the amateurs—a region not considered by the delegates at the Washington conference.

April 1, 1932 brought more changes to the phone bands:

1875—2000 kc
3900—4000 kc
14,150—14,250 kc

Then December 9, 1932, arrived and the amateurs breathed a sigh of relief. The foreign

try to juggle amateur frequencies again failed. Five years of fretting for nothing. The Madrid verdict: No change to the ham bands; and, increased amateur stature by designating amateur radio a service thereby removing it from the "private experimental station" category. But with the good news came some bad: *Another international conference scheduled for Cairo, Egypt, in 1938.*

Cairo, Egypt. February 1-April 8, 1938.

Amateur luck ran out after the Madrid conference. From then on, hams not only fretted, *they sweat!* The Cairo conference dropped the first bombshell: *foreign shortwave broadcasting allowed in the forty-meter band!*

A year before the conference, participating nations received from the Berne Bureau in Switzerland their copy of a book containing the changes each country intended to bring up. The Berne Bureau compiled these from information supplied by the nations approximately six months before. Getting wind through the agendas of pending disaster, seventeen countries in the Americas met in Havana in the Winter of 1937 to consolidate amateur policy in the Western Hemisphere.

By unanimous vote, this Inter-American conference voted to keep all the bands from 1.75 to 60 mc exclusively amateur in their countries and recommended 7-, 14-, 28-, and 56-mc for exclusive amateur use throughout the world. The conference also agreed to change the 160-meter band to 1750-2000 to eliminate non-harmonic overlap, to allow a forty-meter phone band at 7050-7150 for Latin America because terrific static in those countries made phone operation impossible on the lower bands, and to permit 14,000-14,300 mc phone for Latin America, Canada and Newfoundland though the United States elected to continue 14,150-14,250 for American hams. Before adjourning, the Inter-American conference agreed to meet regularly midway between the international conferences, and designated Santiago, Chile, for their next meeting. Two months later the United States entered the Cairo conference armed with the Western Hemisphere decisions and designated spokesman for the Americas.

European and Orient nations lay in wait with heavy artillery, all pointed at amateur frequencies. Organized into combines of like interest, these countries with their government radio monopoly demanded large chunks of the ham bands for broadcast and aviation. Japan even wanted to cut American power. The United States stood pat. "No!" Unable to achieve their aims through debate, the European nations pulled rank according to their rights under the Washington agreement and took sizeable segments from the ham bands. When the smoke lifted from the battlefield, amateur casualties lay exposed: 7200-7300 kc lost to foreign broadcasting; 3635-3685 gone too; and part of 5 meters set aside for other interests. In the Western Hemisphere the bands stayed intact. But, actually, the Americas lost too. Strong foreign broadcasts render much of forty meters unuseable at night.

Before the Conference closed, the delegates adopted America's QSA 1-5 and QRK 1-5 signal strength and readability scales, and changed the International Morse code. (Because telegraph printers of some companies rendered a period as three I's, the Telegraph Conference meeting jointly in Cairo asked the Radio Conference to concur with a change making the symbol for a comma a period, and the exclamation-point symbol a comma). The effective date: September 1, 1939.

Atlantic City, New Jersey. May 15-October 2, 1947.

Between the Cairo and Atlantic conferences, amateurs received numerous band changes from the FCC. See **Table II.** Then the fourth international conference convened. World War II caused the Conference to meet at Atlantic City in 1947 instead of at Rome as planned in 1942. Hams rejoiced. With it once more on home territory, they expected to recoup all their losses. Five months of wrangling followed. At the end, instead of expanded ham bands or foreign commercials knocked out of forty, amateurs lost 50 kc at the high end of twenty and 300 more at the top of ten. Fortunately gains came with the losses. Amateurs

Table II.

Highlights among the pleasantries the FCC allocated to American amateurs during the years between the Cairo and Atlantic City International Conferences.

Frequency		Date
58.5–60 mc	Opened to FM voice	April 13, 1940
28,100–30,000 kc	Designated A-3	July 9, 1941
29,250–30,000 kc	Opened to FM	July 9, 1941
7250–7300 kc	Opened to unrestricted A-3 (U.S. entered World War II following day)	Dec. 20, 1941
114–148 mc 2300–2450 mc 5250–5650 mc 10,000–10,500 mc 21,000–22,000 mc	New Bands opened	Nov. 9, 1945
420–450 mc	1st 10 mc only opened	Jan. 16, 1946
1215–1295 mc	Opened	Jan. 16, 1946
235–240 mc	Opened	March 13, 1946

received as a pacifier the 21 mc band 450 kc wide for their use alone, and picked up internationally the bands above 225 mc. American hams retained 80 and 40 meters intact; foreign hams lost a little more in each. The 21 mc band and the cut in 20 meters became effective in mid 1952.

Geneva, Switzerland. August 17-December 21, 1959.

Following World War II, hams slowly got their bands back. From time to time changes came too. The special license requirement to operate 80 and 20 meter phone disappeared February 18, 1953; forty meter phone opened without restrictions two days later; and the following month the FCC allocated 21,250-21,450 mc for phone. In April 1958 the 3300-3500 mc band shifted to 3500-3700. Four months later, the August calamity hit: hams lost 11 meters to the Citizens!

As the Geneva convention approached, the proposals of participating nations arrived. Hamdom shuddered. One glance showed the magnanimity of the task ahead. Faced with such an attack, how could the United States delegates save hamdom at home let alone help the international hams? The proposals:

1800-2000 kc. India, Poland and Russia wanted to delete amateurs from this shared band.

3500-4000 kc. Argentina proposed splitting the band in our hemisphere giving lower half only to hams. In region III, Australia proposed only 3500-3700 for amateurs. India proposed a maximum of 10 kc for hams somewhere in the lower portion of band. The USSR thought 3500-3650 still shared with government and commercial fixed and mobile stations would be adequate for the hams.

7000-7300 kc. Australia, Poland and USSR proposed 7000-7100 for the hams. (i.e. deletion of present amateur sharing of 7100-7150 outside our hemisphere). India wanted only 7000-7075 for hams. Austria, Belgium, France, Italy, Morocco and Netherlands proposed that Western Hemisphere nations conform to the agreement in the rest of the world and take the top half of the band away from our amateurs with 7100-7150 also available to broadcasting but shared with the hams. Ceylon, Ethiopia, Ghana, Libya, Malaya, Morocco, Pakistan and Tunisia joined in proposing 7000-7100 amateur; 7100-7300 broadcasting worldwide.

When the Geneva Conference convened, the United States delegation consisting of about 100 persons—30 official government delegates, around fifty industry consultants or advisors, and an office staff of twenty—stood their ground for amateur radio, a voice weak in the din of international opposition. Unable to sway their opponents, the American delegation could only watch as foreign nations robbed their amateurs once again. On eighty, our representatives saved the full 500 kc for the United States hams. Elsewhere, each country shared the band to suit themselves with other services. Forty meters stayed put for us too. But not for foreign hams. They lost another 50 kc to the "other interests". Now only 7000-7100 kc remained amateur. Twenty and 15 meters escaped unscathed internationally as also did 10. And, while 50-54 mc stayed exclusively amateur here and in Region III, it received no general allocation in Europe and the Mediterranean countries of Region I.

Where do we go from here?

Any day now announcement of the next international telecommunications conference may come. Probably soon. New nations need frequencies and the satellite era requires communication control. Will amateur radio lose again?

Before the date set for a conference, nations taking part submit suggestions for revising or expanding the present treaty. A short time later, each receives a copy of the submitted recommendations. From then until conference time, countries analyze each others' aims and decide which to support or oppose. To reach such conclusions, the United States government draws from government services, industry and the amateurs.

Knowing that international conference number six lies ahead, let's make sure the United States delegation knows our wishes. If you don't care to contact your Senator or Congressman, remember, the Institute of Amateur Radio (IoAR) exists and will try to do it for you. Apathy will get us nowhere; concerted action will.

Sometimes our delegates must veer from amateur wishes concerning one band to secure better results in some others. Horse trading. That happened at Cairo on forty. Though it spoiled one DX band, it saved the others. Naturally we must live and let live amidst a spectrum that apparently won't stretch. However, let's not make it easy to be robbed. Foreign countries need strong amateur organizations to develop strong electronic industries. Until the International Amateur Radio Unions get this across, our DX bands await a fate similar to the article by an auctioneer's side: Going . . . Going . . . GONE!

. . . W2AAA

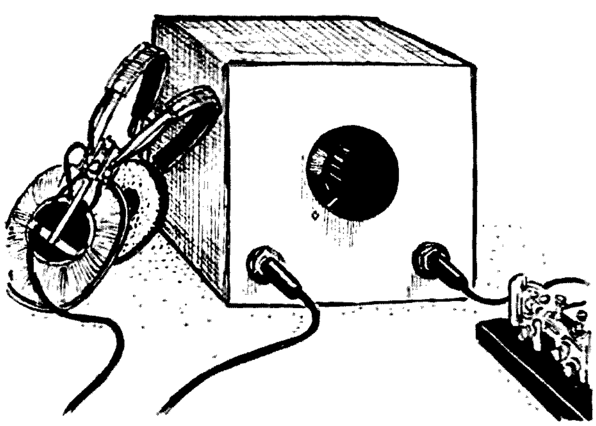
Charles Leedham WA2TDH

Drawings by Wayne Pierce K3SUK

The Zero Meter Band

Back in the October 1964 issue of 73 Magazine, you may have noticed a small ad inserted on page 86, announcing the attempted unloading of mountainside premises somewhere in New Hampshire, complete with a considerable selection of antennas. Within that tempting array, your eye may just have skipped over the fact that it included, and I quote, "Hy-Gain Tri-Bander for O-15-10M." Even if you did happen to notice the peculiar specs on that antenna, almost certainly your eye slid over it, thinking it no more than another of the many typographic atrocities perpetrated by the perenially sloshed typesetters up there on that N.H. hillock, what with it being cider season and all. Only a few insiders were aware of the fact that it was quiet notification by the editor that the old Zero Meter Band was open again.

It was many years since I'd been on Zero the last time, with my original call, and the idea that the band was opening up again naturally brought back many nostalgic memories of old-time operating before the government not only closed it down early in 1942, but confiscated every bit of equipment known to be in private hands.



The Zero Meter band rig.

I never did hear after the war that Zero was open again. The regulations said anything above 40K megs was okay, but I was sure that didn't mean Zero. Mainly because I'd heard stories during the war about the experimental work the government was doing with Zero Meter Radar, and I figured that in the slather of stuff that was ultra top secret afterward they'd included Zero. I didn't want to ask, you know how it is, not making waves and all that. Nobody wants any 3 a.m. visits from conservatively dressed types wearing snap-brim hats wanting to know just how much I knew about Zero Meters, and where I'd learned it, and exactly what was it I talked about to the foreigners on my private radio station. That sort of thing.

Now I figure they must have given up the experimental work because of troubles like the ones I did hear about. There was a fairly well substantiated story that they did work out the antenna problems and get just one Zero Meter radar station working somewhere in England. Up to then they'd been working with stuff as long as ten meters, and were slowly finding out that the shorter the wave, the greater the definition. Naturally, with the zero wavelength on Zero, the definition would have to be pretty good. According to the story, when they fired up the rig and pointed it at a wave of bombers coming in, it was so good they could read the dogtags on the German aircrews. Used to scare the hell out of the Luftwaffe high command by broadcasting back to Germany not only the names, ranks and serial numbers of everybody on a mission, but even their blood types.

Either that last touch finally tipped off German intelligence, or their agents in Eng-

Zero Meter radar was set up in England.

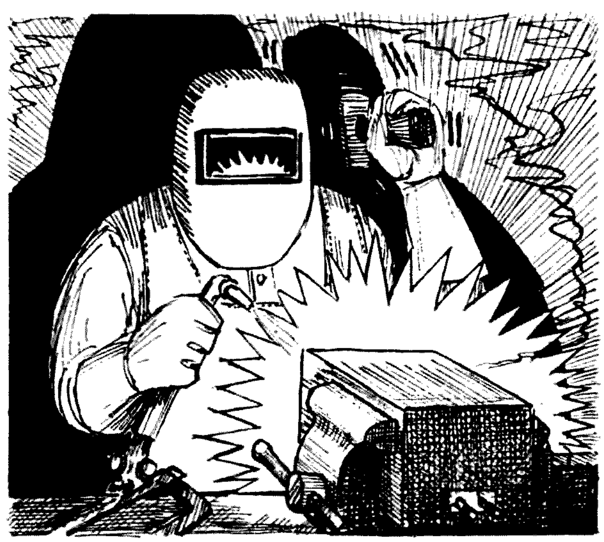
land got wind of what the installation could do, and they pulled a real cutie. Late in '43, I think it was, they sent over a special flight on a bombing run. Had to search all through the Luftwaffe and Wehrmacht for them, I think, but every man Jack of the two thousand crewmen on that flight was named Schultz, rank Feldwebel, blood type AB. Naturally when that list went up to G2 from the Zero Meter Radar crew, some brass-brain upstairs decided the thing must be on the fritz and ordered the techs to take apart the Blue Box. They protested, of course, but orders are orders, so they cut it open with a welding torch. As any of the old civilian Zero Meter ops could have told them, that was the end of that. Whatever was inside was melted into a few droplets of slag by the time they could make a big enough hole to shine a light in, and that was the end of Zero Meter Radar. At least that's the story I got from guys who were near the project.

That was one of the most frustrating things about Zero—those Blue Boxes. You read a lot these days about how sad it is that everybody is an appliance operator and that there's hardly any homebrewing any more like in the old days. There wasn't any homebrew equipment on Zero at all. Everybody I ever contacted on the band was working with the same old Blue Box. As far as anybody knew, they were all World War I surplus rigs; at least we all found ours the same way, knocking around in the junk piles at the backs of the WWI surplus stores. They never did get in the catalogs, because the store operators fortunately didn't know what they were.

It wasn't surprising either, because a Blue Box didn't look like much. It was a small box about six by six by ten, with a dull blue-black crackle finish. There was only one knob on the front, a jack for a key, another for phones, and an antenna terminal on the back. No label, no brand name, nothing. Just a plain Blue Box, except for the peculiar business about there being no sheet metal screws or rivets, or any way at all to open it up.

Some of us tried, of course. Any ham would be curious about the circuit and components that could handle that kind of frequency. But drill bits got blunt and hacksaws didn't seem to have any effect, so we gave up on that angle and just operated. We all heard about the guy who couldn't take not knowing and went at his with the blowtorch. He never showed up on the band again. Just like with the radar unit, when he got it open he found everything inside melted down. One of us—I don't remember now exactly who—got a postcard telling what happened, and about how he was looking all over the country for another Box, but he apparently never did find one.

We had to admit that the theory of it was beyond us, which is why we never got very far in homebrewing, or even in drawing up tentative circuits. After all, how do you design a tank circuit that is resonant at infinity megacycles? That, unfortunately, is the way it goes on Zero. If the wavelength is zero, you can't fight the fact that the frequency has got to be infinite. Some of us had a few bright ideas about designs, but search as we would through the old catalogs, we never could find specs for components that would come close to what we'd need. Maybe soon, with some of the new microminiature stuff that's coming out, but back then there wasn't



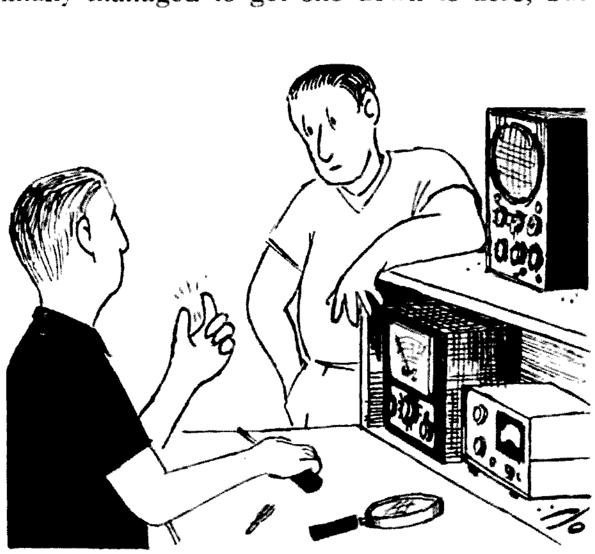
Of course, it was hard to open up the Zero Meter rig.

a tube on the market that could handle infinite frequency. At least not with enough gain to make it worthwhile wiring into a breadboard circuit.

The frequency, of course, was why everything on the band was CW. If you think about it a little, you'll see that modulating a wave means you are adding to it and subtracting from it. And if you've had the math, you know that no matter what you add to or subtract from an infinite frequency, you still have the same frequency at the output. Maybe phase or pulse modulation might be the answer, but we didn't know enough about that sort of thing then.

That was the reason the old Blue Box was so simple, too. If you're rock-bound on a single frequency, you don't have to worry about tuning and loading and such. There was only that one knob, which was on-off and receive volume. No VFO or frequency read-out, of course, because you can't QSY on Zero, for the same reasons you can't modulate it. And when I say rock-bound, incidentally, I say it because I imagine that was the way it was done in whatever circuit was inside the Box. We did a lot of speculation about it on the band in the old days, laboriously tapping out our theories to each other. About the only thing we came up with was the fact that it had to be that way—seeing as a crystal gets higher in frequency as you grind it down, then if you keep grinding and get it down to zero thickness, then it has to oscillate at an infinite frequency. Makes sense.

I tried once, figuring if I was ever going to build up a circuit on my own I might as well start with the crystal. I ground and ground away, and after ruining a lot of stock finally managed to get one down to zero, but



Building a Zero Meter beam.

as soon as I tried to pick it up the damned thing shattered. That was the last time I tried working on zero-thickness crystals. I'd worked so hard mastering the technique of getting them down to zero thickness—and that's precision work, believe me, with no tolerances at all—that I didn't want to spend another year or so figuring out how to handle anything that thin without breaking it.

My crystal fiasco naturally brings to mind the story of poor Joe, who was experimenting with the antenna end of things. That was one of the real pleasures of working on Zero, the fact that you could work up a really fancy antenna and not have to worry about space or big hunks of metal hanging up there in the sky to worry the neighbors. On Zero, you can obviously have all the elements you want, on a zero length boom, and with zero length elements. You have to be pretty careful about spacing, though. If you're off by even the littlest bit your directors start acting like reflectors, and you end up with a pretty confusing polar plot.

I never bothered with more than 42 elements on my own beam, but Joe decided he was going to go for broke and really put out the rockcrusher signal of the band. You know how some guys are if they don't get forty-over reports every transmission. Joe'd worked on his beam for over 12 years and managed to fit something over four thousand elements onto the boom—he'd lost track once, and wasn't sure exactly how many he had, because of the difficulty of counting zero-length elements on a zero-length boom with zero spacing—but he did know he'd put on more than four thousand. Then one day he had the beam taken down and in his shack to add still some more elements, and while he was out getting some more zero-diameter aluminum element stock his wife came into the shack and opened the window. I need say no more than that there was a strong breeze that day, and poor Joe never found his beam again.

At the trial, Joe kept sobbing so piteously and mumbling over and over, "Gone, gone, gone" that the jury couldn't believe anybody that grief-stricken could possibly be responsible for his wife's mysterious disappearance. It took the spirit out of Joe, though, all those years of work lost, and the last I heard from him he was working low frequency, down on the 20-Micron band.

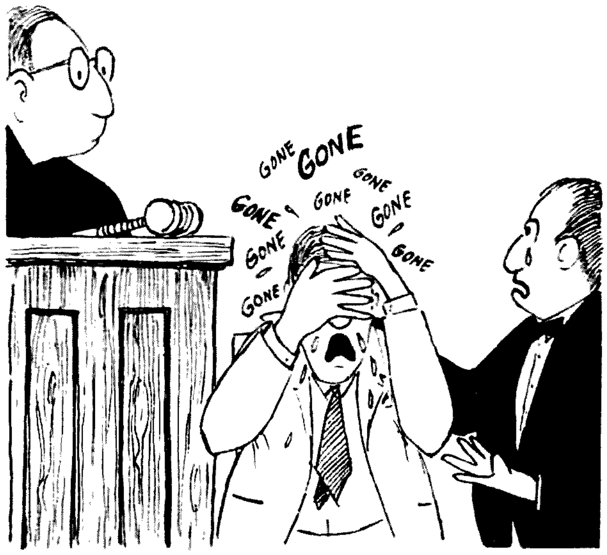
I think Wayne was a little reluctant to let the news about Zero get around too much, which is why he gave us OOT Zero ops the word in such a coded fashion. But I've managed to convince him that somebody has to

get out a warning about Zero antennas just in case one of you stumbles across a Blue Box up in the attic, or finds one in a surplus store. We're both convinced that there aren't any left, but still, just in case.

The warning is this: whatever you do, never use a long-wire antenna on Zero. All of us on the band back then knew enough about antenna theory to know what was likely to happen if we put even a one-inch wire on that antenna terminal and operated it as a wire antenna instead of running a feed-line to a properly designed, resonant Zero Meter antenna. If you look at the charts in the manuals, you'll see why yourself. The gain of a long-wire goes straight up as the antenna lengthens in terms of wavelengths, and there doesn't seem to be any fall-off.

Consider the wavelength of Zero, and you see right away that any length of wire at all contains an infinite number of wavelengths. That means, of course, infinite gain in the antenna, which means that the minute you hit the key you'd put out an infinitely strong signal. It would slop over onto every other frequency in the spectrum, still with infinite strength, and blow out the front end of every other receiver in the world. And eventually in the universe. It would only be a split micro-second pulse, but enough. Or maybe that strong a signal would instantaneously melt your longwire, and thus no signal would get out at all. I'm not really that strong on theory, but that's the way we used to figure it—that it would last long enough to get that infinite-gain signal out—and so we never dared try to see if it was right. If you should find a Blue Box, take heed!

The reason I'm back on Zero is that when the big confiscation came, I turned in the Box I was operating with, and completely forgot that I'd picked up a spare, and that



Joe kept sobbing pitifully at his trial.

it was lying behind a lot of other old radio junk in the cellar. But when I read Wayne's ad I suddenly remembered it, after all these years, and went down and found it. I dusted it off, plugged it in, and put out a tentative CQ. Much to my surprise there were some answers, so pretty much the same must have happened to some other guys.

I recognized a few of the calls, and it was a real pleasure to meet old friends on the band. There were a few pretty strange prefixes coming in, though, and when I asked one of my contacts about his exact QTH—but that's another story.

Dig into the backs of those WWI surplus stores. There may still be a few of them around. Maybe you'll be lucky enough to find a Blue Box. Just be extra careful about not putting on a long-wire, and I'll see you on Zero.

. . . WA2TDH

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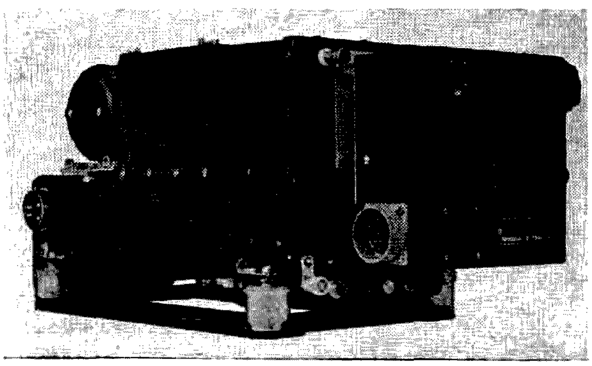
Automatic Tuning for the ARC-5 Receiver

The typical aircraft Command Set installation used a remote control station located for convenient operation by the pilot or, in some cases, another crew member. The receiver and transmitter were fitted into whatever space was available and tied together by cables. Flexible shafting was used for remote tuning of the equipment.

Some Navy aircraft installations precluded the use of flexible shafting and a motor driven remote tuning unit, the C-131/AR Automatic Selector Mechanism was developed for use with AN/ARC-5 and Navy ARA Command set receivers. This automatic tuning has been spottily available on the surplus market. More plentiful have been the ARA and AN/ARC-5 receivers with the C-131/AR installed. The photograph shows a Command Set receiver with the motor driven control unit in place.

It is not feasible to remove the automatic tuning system from the receivers since the original dial and drive were discarded when the control unit was installed. Manual operation of the receivers is not changed from the original and the direct drive tuning knob is a bonus not found with the run of the mill Command Set receivers. A further advantage is that the modified receivers may be used for mobile operation and located in the trunk of the car. While the remote assembly was designed to operate from a 20 to 30 volt dc source, they will work from a 12 volt dc system.



The C-131/AR installed on an ARC-5.

The schematic diagrams of the drive assembly and the remote selector switch are shown in Fig. 1. Circuit elements referred to in the following discussion are keyed in the diagram by circled letters. The unit contains six selector disks with contact segments (A) separated by gaps (E). The angular position of the gaps controls the setting of the receiver tuning capacitor, and the position of each disk may be set by a front panel screwdriver adjustment. Contact arms (B) are mounted on a common shaft (D) which is geared to the motor drive. Direction of motor rotation is determined by the motor winding (C) selected by the relays (R). The two contacts of the remote control switch associated with each of the six positions are wired to corresponding segments (A) of the six selector disks.

When the remote control switch is set to a given position, the circuit is closed through a disk segment (A) and one of the two relays (R) is energized through the contact arm (B). This relay closes the circuit through one of the motor windings (C) and the motor turns in the corresponding direction. The mo-

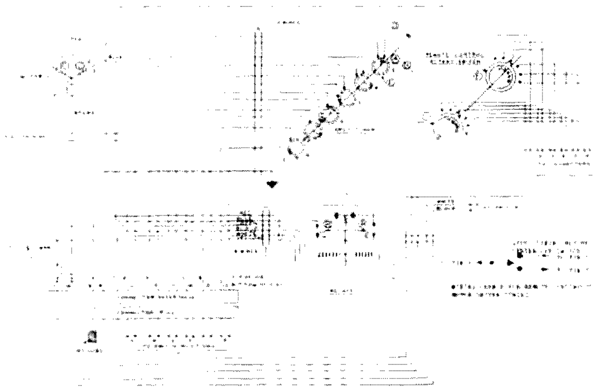


Fig. 1. Schematic diagram of the C-131/AR automatic selector mechanism.

tor turns the receiver tuning drive and the contact arms until the contact arm bridges the gap (E) between the disk segments. Both relays are then closed, removing voltage from the motor and the drive stops at the preset position. Turning the remote switch to another position will start the tuning cycle again.

For operation from a 12 volt dc source, the relays in the C-131/AR unit must be adjusted. Remove the cover and decrease the armature spring tension of the relays until they operate reliably on 12 volts. If spot frequency reception is desired, wire a six position, two gang switch to the unit as shown in Fig. 1. Connect the auto battery "hot" lead to Pin 17 of the receptacle and the ground return to Pin 16. Make no connection to Pin 9. Polarity is not important; while direction of rotation will change, the system will still work.

To set up the spot frequencies, turn the front panel switch to the "Auto" position and slide back the covers from the front panel channel adjustment screws. Set the remote switch to the desired channel and turn the corresponding channel adjustment screw until the receiver tunes itself to the desired frequency. Set up the balance of the channels in the same fashion.

If continuous remote tuning is desired, delete the remote selector switch and associated wiring. Connect battery to Pins 16 and 17 of the connector and wire a spdt, center off, spring return switch as shown in the Fig. 1 inset.

The motor driven tuning feature of the C-131/AR control unit does have practical amateur application. Even if the receiver is installed under the instrument panel, the motor driven tuning saves a lot of inconvenient, and often dangerous, knob twisting. In any event, this article answers the question of what the "little black box" was used for.

. . . W4WKM

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Boosting Talk Power in ALC Transmitters

One of the big premises on which the advantages of SSB over conventional AM phone is based is, of course, the high peak power level—sometimes exceeding CW ratings—to which most transmitting tubes can be driven. However, much of the advantage dissipates when it is recalled that the "average" voice drives the usual SSB rig to but 30 to 60 percent of PEP ratings, hitting top peaks only occasionally.

Regular audio speech clipping, which has been applied successfully to AM phone for many years to increase the average modulation level, does little to improve matters in SSB. Well-designed audio compressors (or even better, compressors applied to the SSB RF waveform *itself* in some intermediate stage in the transmitter) represent the ultimate in attaining *average* power near the PEP ratings for which the transmitter was designed. Unfortunately, such units—especially the RF compressors, which require an additional SSB crystal filter—are costly and can not be easily installed in the cabinets of most rigs to make a completely self-contained unit.

A poor-man's approximation to the compression and limiting action of these accessories can be had very easily for only a couple of dollars and a few minutes' time if your rig employs automatic load control (ALC).

Most of the circuits work like this: When no final amplifier grid current is drawn, a normal bias exists at the grid of an earlier intermediate amplifier or driver stage, providing maximum gain. When final amplifier grid current begins to be drawn, the circuit generates a rectified voltage (which follows audio peaks), applying this voltage as an additional bias to the intermediate amplifier. This effectively decreases the gain of the stage, and consequently, the driving voltage that is applied to the grid of the final amplifier. The whole process is remarkably similar to the standard AVC action in communications receivers.

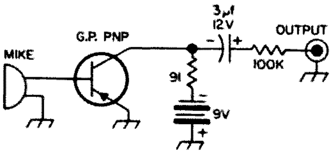

Fig. 1. The transistor preamplifier described in the text.

ALC in the SSB transmitter improves performance by making it difficult to seriously overdrive the final amplifier with its resultant "flat-topping" and distortion, and by indirectly providing a measure of speech compression. But because the ALC is asked to work over too-wide a range of levels, corresponding to the complexities of human speech, it cannot markedly increase the average-to-peak power ratio.

An improvement can be had by adding a simple microphone pre-amplifier ahead of the first speech amplifier stage in the transmitter. By driving the speech amplifier very heavily —but below the point of serious distortion— a measure of speech compression can be obtained in conjunction with the ALC circuit.

Fig. 1 shows the schematic diagram of a miniature one-stage transistorized preamp which can be built into most crystal or dynamic mike cases.

The preamp was built into the case of an Astatic D-104 crystal mike, and a miniature 9-volt battery was mounted within the mike stand. Most communications mikes have ample room within the case for the entire preamp. While good results were obtained with the D-104, even better performance could be expected from one of the newer, specifically-designed SSB mikes.

In practice, the rig's audio gain control is operated at a much lower level; the rig is talked-up by advancing the gain control to just below the point where flat-topping begins to appear. On-the-air comments with the preamp, using a Heath Marauder, brought universally favorable comments on the audio "punch" and quality, with no noticeable distortion. The mike should be held several inches from the lips or held sideways, however, to prevent "blasting" from breath noises.

Although not tried in a non-ALC transmitter, the little preamp should give some limiting action, though undoubtedly not as much as it would produce in an ALC-type rig.

. . . K2IKZ

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Seeing Your SWR

During the past decade, literally scores of devices for checking out SWR, antenna impedance, and related items have been described in the amateur press. They include bridges, directional couplers, and other exotic hardware.

But one of the simplest and most useful devices has apparently been overlooked during all this time!

The device (a technique, really) we're talking about will (1) give you a direct visual picture of your SWR curve, (2) give you a direct measurement of impedance vs. frequency over any desired passband, (3) tell you how much loss exists in your feedline, and (4) do all of these things at the same time with a single hookup and test. Interested? Read on.

We'll start by saying that this is nothing new, as such. Some manufacturers of antenna feedline have used the technique for years; if you've ever seen an advertisement for "frequency-swept" coax, you've been exposed to the results of this technique. But so far as we know, hams just aren't applying it.

A large part of the reason for this may be that it required two items of test equipment, neither of which could be considered common in a ham shack until the past few years. One is an oscilloscope, and the other is a "sweep generator." The scope is seen in more and more shacks these days, though the sweep generator still can't be called common.

However, a sweep generator adequate for the purpose can be easily built, and a number of them have been described recently. So we'll assume that you have, or can get hold of, both the sweep generator and the scope, and start from there.

The technique is extremely simple; merely hook up the sweep generator to the feedline or other device to be tested for impedance (through a terminating pad), and use the scope with an RF probe to measure RF voltage across the impedance at the same point to which the sweep generator is connected. Fig. 1 shows the scheme.

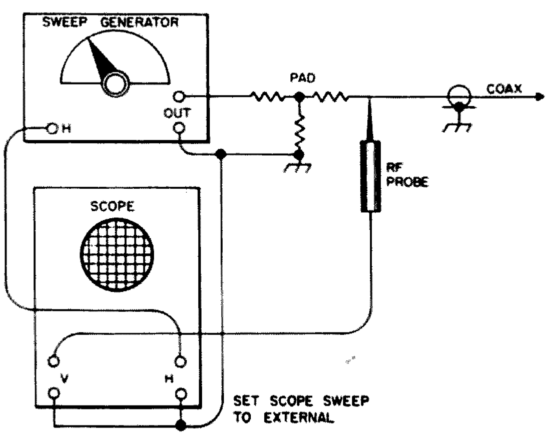

Fig. 1. Basic set up for seeing your SWR.

You don't need a fancy scope to do this, either. With the RF probe, the RF voltage is transformed to DC. Since the sweep generator *does* sweep across its band at a regular rate, any variations in RF voltage (and consequently in DC output of the probe) occur at the same rate as the sweep. In most gear, this is 60 cycles per second, and virtually all scopes will handle a 60 cycle signal adequately.

When the load is "flat," though, there are no variations in RF voltage and as a result the output of the probe is pure DC. If your scope happens to be of the DC variety, you

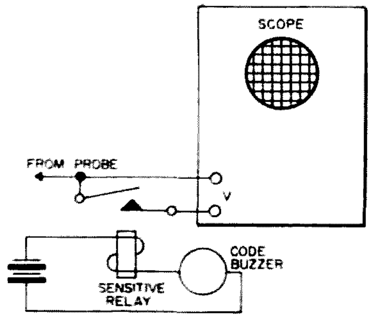

Fig. 2. Chopper circuit necessary for AC coupled scopes.

have no problems at all here. If not, hook up a "chopper" as shown in **Fig. 2** to give you a zero-reference line. Now any DC output from the probe will appear (to the scope) to be AC square-waves, at the frequency at which the chopper operates. If a code buzzer is used, this frequency will be around 1 kc, and since the sweep rate is so much lower, the scope trace will approximate a pair of straight lines for a flat load.

To calibrate everything, provide a dummy load of the same impedance as the coax cable you're using and hook things up as shown in **Fig. 3A.** Most commercial sweep generators are designed for 75 ohm output, which is why we show 75 ohms rather than the more common 52 ohm coax. Make sure that the dummy load really is flat at the frequency you're interested in, then turn things on.

If everything is working right, you should get the "perfect trace" pattern of **Fig. 3B.** The upper line is the "load" trace, while the lower one is the zero reference. The distance between them is proportional to the DC voltage developed in the probe by the RF across the 75 ohm load.

It may happen, though, that the sweep generator doesn't give you a constant output over its sweep band. In addition, sometimes probes have resonances which tend to foul things up. If either of these happens, your trace will look something like the "non-linear trace" picture in **Fig. 3B.** The bumps and dips may be at different places, but at any rate you won't have a nice smooth straight line.

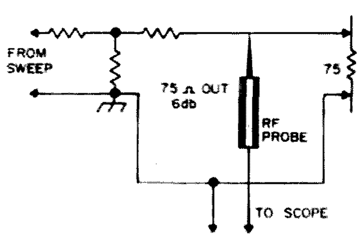

Fig. 3A. Calibrating the scope.

Don't let it bother you too badly. It will complicate things a bit, but not excessively. Simply take a grease pencil and trace over the line, no matter how jagged it is. The grease-pencil tracing then becomes your standard of a "flat" line, and SWR is figured by noting departures from the tracing rather than from absolute flatness in the later stages of the measurement.

This is the point, incidentally, to start wondering how this idea works. **Fig. 3A** is almost obvious; as the sweep generator sweeps its frequency band, the RF voltage across the resistor stays the same and so probe output also stays constant. The chopper lets the AC scope display the result, and you get **Fig. 3B.**

But what if, instead of a 75 ohm resistor, we have a length of coax which terminates in an antenna? This, after all, is what we want to measure.

Before getting into that, let's see what happens if we use just a length of coax terminated in a resistor. Let's make the coax a full wavelength long at 400 mc, which is a shade under 20 inches (after allowing for velocity factor) and is a nice convenient desktop size. Let's also assume that our resistors are still pure resistance at 400 mc, though of course we know that's not quite true.

Now let's hook a 75 ohm resistor across the far end of the coax from the probe and start sweeping around 200 mc. Since the load is an exact match to the line (under the assumptions we made) all the power from the sweep generator goes on up the line and is dissipated in the load resistor. It makes no difference just what the exact frequency is; the load is not frequency-sensitive under our assumptions.

But if we hook a 150 ohm resistor on the far end instead of the 75 ohm unit, we have introduced a 2-to-1 SWR on the line. What this amounts to is that not all the power going up the line to the load can be absorbed by the load; some is reflected back down the line. In **Fig. 4** the block marked X represents the measurement point, and this is where we measure the reflected voltage. With a perfectly matched load, E_{refl} is zero, but with

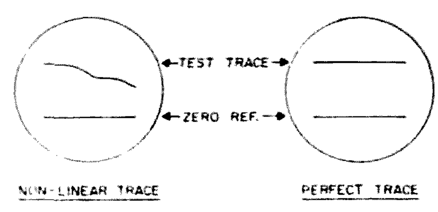

Fig. 3B. Typical traces from the circuit of Fig. 3A.

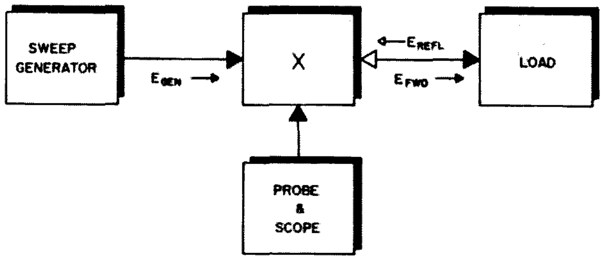

Fig. 4. Explanation of the scheme to see your SWR.

a mismatch at the far end, E_{refl} exists. It may be nearly equal to E_{gen} if SWR is extremely high and line losses are low.

At point X, the voltage we will read with our probe consists of the *sum* of E_{gen} and E_{refl}. If they both happen to be in the same phase, the voltage at point X will be higher than that of the generator alone, while if they are out of phase with each other, the voltage will be less. Phase at point X depends on both frequency and line length.

The phase of E_{refl} is determined by the time it takes for the outgoing signal to get to the end of the line and come back to point X, and thus depends on the frequency of the outgoing signal if line length is fixed. What this means is that, at some frequencies the voltage at point X will be greater than that of the generator alone, while at other frequencies it will be less. In between, it will vary from positive to negative peak values.

Now let's go to **Fig. 5**, which shows four typical scope traces. **Fig. 5A** is simply our perfect reference trace all over again; this is what we get with a flat line. The two traces are exactly parallel.

Fig. 5B shows what happens if we use the example just cited and sweep from 100 to 400 mc. At 100 mc, the total line length from point X to load and back to point X is ½ wavelength. When the signal reflects at the load, its phase is shifted 180 degrees, and the half wavelength out-and-back which it must travel adds another half wavelength or 180 degrees to its phase delay. The result is that E_{refl} and E_{gen} are in phase, and the voltage at point X is at its peak.

When the sweep generator reaches 200 mc, the round trip from X to load and back is a full wavelength, which leaves the phase of the reflected voltage unaffected. Since it was already shifted 180 degrees by reflection, it is exactly out of phase with the generator voltage, and the total at point is at a minimum.

At 300 mc, round trip distance is 1½ wavelengths and the situation is the same as at 100 mc; at 400 mc, the distance becomes 2 wavelengths and the 200 mc argument applies.

The frequency markings on the zero reference, by the way, are there just for the example. Don't expect to find them on your scope.

In between the peaks and valleys, the total voltage at point X is somewhat between the extremes we've discussed. If you were to duplicate this example with such an extreme sweep range, you'd find that the trace would be a perfect sine wave. At this point, what you have on your scope screen is an actual picture of a standing wave on the line!

The peak value of the reflected voltage depends, naturally, on how much voltage is reflected, and this in turn depends on the amount of mismatch at the far end. Since SWR is just a more convenient way of saying "amount of mismatch," the lines shown dotted in **Fig. 5B** could be drawn on the scope face and marked "SWR=2." Similarly, all other values of SWR could be calculated and the scope face caibrated for them.

Normally, we would never use such a wide sweep range. Let's narrow the sweep width down to cover just the area between 180 and 225 mc and see what we get. It's shown in **Fig. 5C**, and as you can tell is simply a horizontally-expanded version of that portion of the curve around 200 mc in **Fig. 5B.** We also changed the vertical gain setting for this

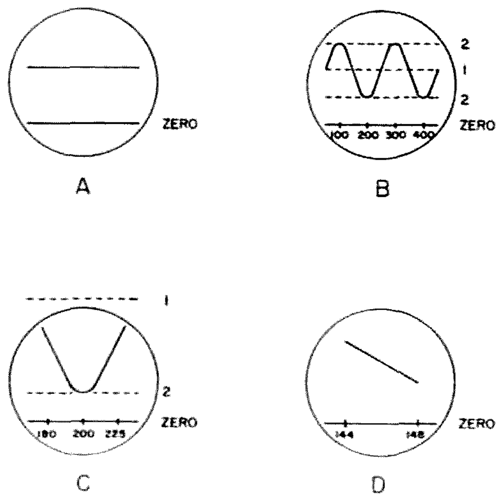

Fig. 5. Typical scope traces. See text for explanation.

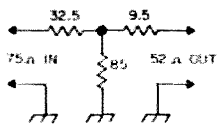

Fig. 6. 6 db pad for matching 75 ohms to 52 ohms.

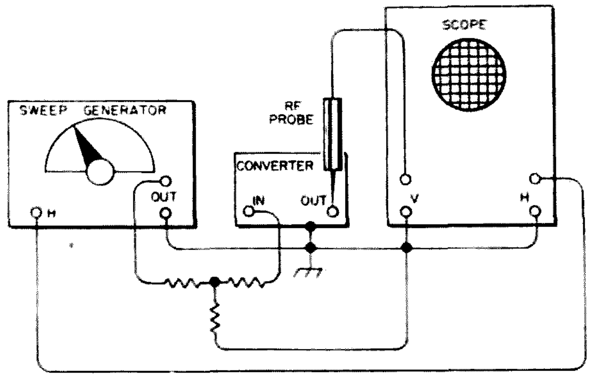

Fig. 7. Aligning your VHF converter.

drawing, as indicated by the different positions of the SWR-calibration lines, to make more clear what happens. In practice, this is the kind of curve to expect. If your sweep range includes the frequency of lowest SWR, the trace will resemble **Fig. 5C** or its image (upside down).

Should you get a trace which looks like **Fig. 5D,** you are sweeping a band far removed from the frequency of lowest SWR. Retune the sweep generator until you get something like **Fig. 5C,** and you'll be in the right ballpark.

Keep in mind that so far, we've been talking simply about a mismatched transmission line, with a resistor at the far end. The position of minimum SWR is determined by line length in this case. But if the line terminates in an antenna instead of in a resistor, which is the case we really want to check, then the picture changes.

For instance, let's assume a dipole antenna cut to resonate at 7.1 mc, and sweep from 7 to 7.2 mc.

Right at resonance, the antenna will be a pure resistance, and to keep things simple let's assume that it matches the line perfectly. At this stage, SWR is 1 to 1, and at the resonant frequency the trace would be flat; it would be just as far from the zero as if a resistor were on the end of the line.

As we go below resonance, to 7 mc, the antenna begins to look like a capacitor, and the SWR rises. Some voltage is now reflected back down the line, and our scope trace will depart from flatness.

Above resonance, around 7.2 mc, the same thing happens again. This time the antenna appears inductive, but the effect is similar. Voltage is reflected back down the line, and the scope trace changes again.

The important thing is that, on either side of resonance, the voltage at point X changes. It will change in the same direction regardless of being above or below resonance; the direction will be determined by line length, but no other characteristic will be affected.

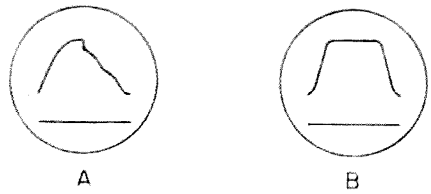

Fig. 8. Typical traces when aligning a converter.

What you come out with is a trace that looks like **Fig. 5C,** except that the trace now touches the 1-to-1 SWR calibration line instead of passing through it to touch the "2" line. If the antenna isn't matched to the line at resonance, the trace will be either above or below the "1" line because of SWR. In either case, if you have some idea of vertical-scale calibration you can get a direct reading of your VSWR.

To get this idea of the vertical-scale calibration, you could measure the SWR of your antenna at several points over the band (say at 7, 7.1, 7.2, and 7.3 mc) with a good SWR meter. Next, sweep the band with the hookup described here, and read the vertical grid in arbitrary units. Using a frequency spotter, find the points on the trace which correspond to the frequencies at which you took SWR measurements, and make up a chart relating "vertical units" to "measured SWR" at these points. You will find that they fall into a simple relationship, and from that point on you can tell the SWR at any spot on the trace by reference to your chart relationship.

The disadvantage of this idea is that it is good for only one setting of the sweep generator, and sometimes for only one line length! A more general technique for calibration involves a little bit of arithmetic, but can be applied anywhere. Here it is:

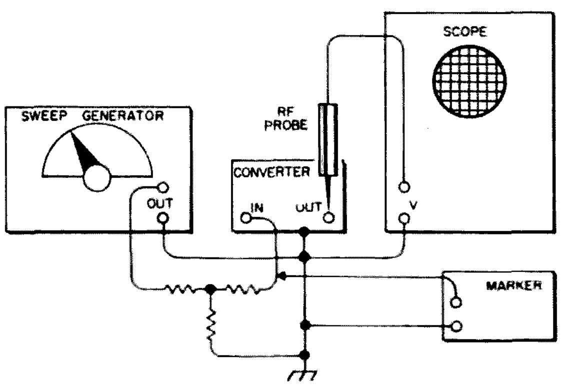

Fig. 9. Adding a marker generator.

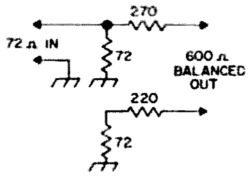

Fig. 10. 75 ohm to 600 ohm balancing pad.

VSWR Table

Ratio A	VSWR
0.0	1.00
0.1	1.22
0.2	1.50
0.3	1.86
0.4	2.33
0.5	3.00
0.6	4.00
0.7	5.67
0.8	9.00
0.9	19.00
1.0	infinite

By removing the coax and hooking up the calibration circuit of **Fig.** 3A, you can determine how many vertical units of voltage you would have on a completely flat line. When you reconnect the coax, you can tell from the screen how many units of voltage are actually present at point X, for any specific frequency. By counting vertical units from the "flat" voltage to the final trace, you can tell how much reflected voltage is present.

Once you have values, in the same "vertical units" for both the "flat voltage" and the reflected voltage, you can proceed to the VSWR formula. It requires that you first divide the reflected voltage by the forward voltage to obtain a ratio which we'll call "A," then solve the equation: $VSWR = (1 + A)/(1 - A)$.

All you really have to do is to obtain ratio A in a decimal-fraction form, then look in the ARRL Handbook's "RF Measurements" section for their calibration curve on the "Monimatch" type of SWR meter. This is the curve of the VSWR equation, and it can be read directly.

And if you don't have a Handbook handy, we've put together a table of VSWR vs. "ratio A" which can give you a quick idea of your VSWR.

All this time we've been talking about the use of the sweep technique for a specific application with a specific value of impedance, 75 ohms. What about other impedance values?

If they're fairly close to 75, you can use an impedance-matching pad for terminating the sweep generator. This is a T-pad designed to see 75-ohm impedance on one side, and whatever impedance you desire on the other. To perform its job properly, such a pad must have a certain minimum loss, and the greater the separation between the two impedance values, the more loss necessary. To match 75 to 52 requires **6** db, which isn't prohibitive. **Fig. 6** shows a suggested matching pad for this purpose. For best results, resistance values should be as accurate as you can get them, even though they're not standard. And the resistors *must* be non-inductive.

But what if you want to see the trace of a high-impedance grid circuit, for instance?

One way to do this is to wind a link on the resonant tank, coupling and tuning the link so that it looks like a perfect match to either 52 or 75 ohm coax when the grid circuit is at its proper impedance level. Then sweep the input circuit, coupling in through the link. Any impedance variation in the high-Z circuit will be reflected back as a change in impedance of the link, which will in turn show up as increased SWR on the scope trace. By this technique, bandpass circuits can often be adjusted to have just the characteristics you desire.

To determine the loss of your feedline, climb the tower and put a good short across the feedline right at the antenna. Then come back down and sweep the feedline in the neighborhood of your frequency, changing sweep generator center frequently as necessary until you get a trace looking something like either **Fig. 5B** or **5C.**

If the line had no losses, the negative peak of the trace would come right down to touch the zero-reference line, because all the voltage would be reflected back down and you would get perfect cancellation.

But in practice, the loss in the line will keep the negative peak from quite touching the zero reference. The amount by which it misses indicates how much loss you have; the less separation, the lower the loss.

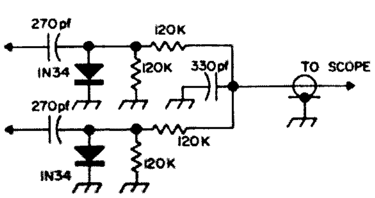

Fig. 11. Balanced RF probe.

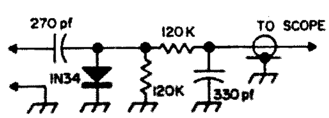

Fig. 12. Unbalanced RF probe.

To measure loss exactly, determine the amount by which the peak misses zero, and also the "flat voltage" just as in measuring SWR. Then calculate the corresponding "ratio A." This is the *square* of the fraction of voltage lost in a one-way trip up the line, since your measurements were made on a round-trip basis. But since power varies as the square of voltage, it is also *directly* the fraction of power lost in the line on a one-way trip, and can give you the loss in db.

To convert this power fraction into a decibel figure, simply look in a power-to-db chart. The result will be the db loss in your feedline.

Oh yes; don't forget to go back up and remove the short before turning on the rig!

While you have everything hooked up you might want to take some readings on any VHF converters lying around the shack. A few connections would have to be changed to do this, but not many. The equipment arrangement is shown in **Fig. 7**; the major difference is that the RF probe is moved to the converter output.

The sweep generator should be covering the band for which the converter is designed, with at least half again the bandwidth of the converter on either side. For instance, if you're checking a 6 meter converter the sweep should be from 48 to 56 mc. As always, calibrate the setup first by hooking a dummy-load resistor across the sweep-generator's terminating-pad output and tracing the resulting display with a grease pencil on the scope face.

Then move the probe to the converter output as shown in **Fig. 7** and sweep away. Most likely, the first display you'll see will be a lopsided curve like that of **Fig. 8A.** With a bit of care and patient tweaking of all tuning adjustments, you should be able to get it looking like **Fig. 8B.**

To tell just where you are in frequency, a "marker generator" may be added to the hookup as shown in **Fig. 9.** The marker output, hitting the RF probe along with the sweep output, causes an audio beat. The resulting audio signal at the probe output causes a pip to appear on the trace whenever the sweep and marker generators zero-beat with each other.

The marker may be your regular station VFO, with as much of the transmitter as necessary to get output of about the same strength as that of the sweep, or it may be a 1 mc crystal oscillator as used in frequency standards. With a 1 mc oscillator having high harmonic output, pips will appear every megacycle across the trace, giving a convenient calibration of frequency.

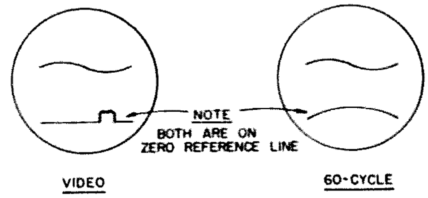

Fig. 13. Improper signals resulting from spurious pick up.

All this way, we've been talking about coax and other unbalanced systems. What about the balanced variety?

It works just the same way except that the sweep generator's output must be made balanced by using either a set of balun coils or a balancing pad, and a balanced probe must be used.

Fig. 10 shows a 75-to-600-ohm balancing pad, while **Fig. 11** is the schematic of a balanced probe suitable for any impedance level. If you want to build an unbalanced probe instead of buying one, use the schematic of **Fig. 12.**

In either case, use normal caution in wiring the probe. The balanced probe, especially, requires as perfect balance as you can get between its two sides. Unbalance will result in inaccurate readings. The best way to get the balance in the first place is to make everything physically symmetrical, and the way to check it is to measure a resistor or other known flat load.

When measuring out an antenna system, you may run into trouble from TV stations or strong locals riding through and showing up on your scope trace. Also, 60-cycle hum may be picked up from house wiring. The pattern contributions from these sources are shown in **Fig. 13.** There's little you can do to avoid them, but when you know what they are they can be ignored.

For additional data on these subjects, a wide range of books is available. The subject of probes themselves and some more applications of this technique are covered in *Probes,* by Bruno Zucconi and Martin Clifford, published by Gernsback Publications Inc. The subject of SWR is taken up in detail in a paper-bound book titled *Microwave Transmission Design Data* by Theodore Moreno and published by Dover Publications Inc. Don't let the imposing title frighten you; the data can be understood by anyone who has waded his way through the Handbook, and there's far more detail and explanation as well. . . . K5JKX

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The 1215 Transistor Superhet

Part II: if, af and assembly

This article is the third part of the UHF transistor superhet receiver series that started in the December 73. The first article described the mixer and the second the oscillator. This one takes care of the *if* strip, audio amplifier, final assembly and a simple antenna.

Basic *if* amplifier

Fig. 1 shows the basic 28 mc *if* amplifier. It has good gain so three stages are all you need for the complete *if* strip. The Sprague 2N1726 costs under $1.25 and does a good job. You can use the 2N1745 for a little more gain if you wish.

It will pay you to go through this circuit carefully as there are certain principles which, if followed, will give you a good understanding and confidence in stable HF transistor amplifiers.

The DC bias for the base is inserted through RFC1. C1 isolates that DC from any other DC voltages or ground that might be present on the input cable or connections. If the input is another of these stages (shown at L3), RFC1 and C1 are not needed. A low impedance cable or link should be connected to A and B while testing or the stage may oscillate. It won't take off in the final *if* strip.

The base bias is shown as adjustable. This is to set the gain and current at the correct point, but fixed resistors are used in the final circuit. As a general rule, you can use 5 k from base to ground and about 33 k from base to the minus 12 volts.

A good place for an *if* gain control is in the the emitter circuit. Add a 5 or 10 k potentiometer (actually rheostat) to R3-but be sure to keep R3 in the circuit.

Some shielding is advised. A much smaller model makes this even more important. Put the transistor base connection close to a hole in the shield and run the base lead through it with a short wire. A word on *if* feedback and regeneration is due here. Feedback from the collector to the base circuits will produce oscillation of course, but much less feedback will produce much greater regeneration between the three stage amplifier input and its output. Watch out for this when completing and cabling the whole package.

Now coming to the collector circuit and L1.

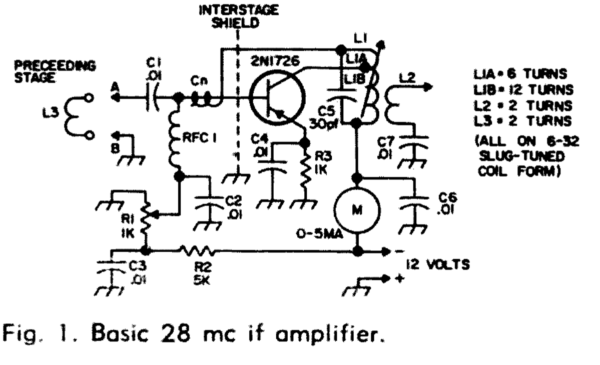


Fig. 1. Basic 28 mc if amplifier.

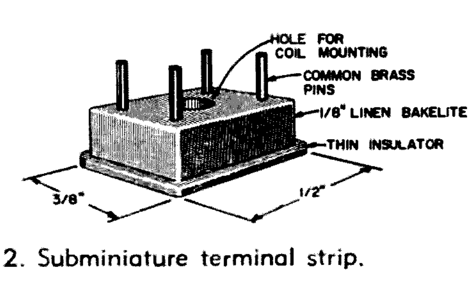
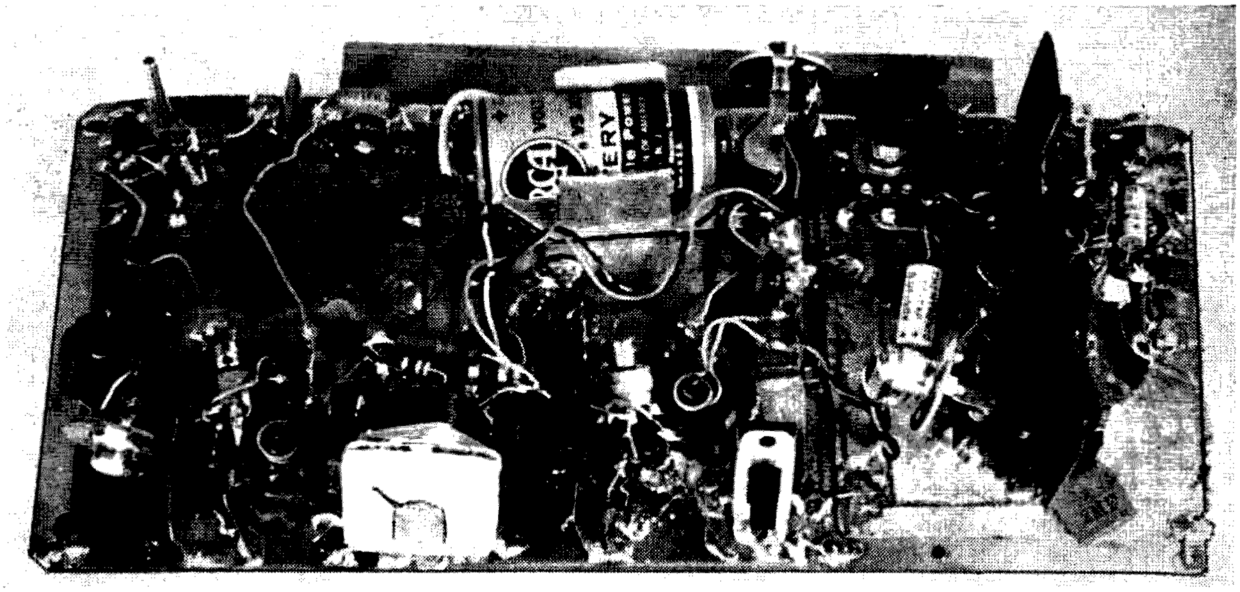


Fig. 2. Subminiature terminal strip.



The 28 mc if amplifier strip. It's built on a piece of copper clad bakelite with shields between each of the three stages.

This is the heart of the amplifier. I like the 6/32 internal threaded paper coil forms because they are small and only cost a few cents apiece. There must of course be some method of tuning the stages, whether by making C1 a trimmer or by adjusting the powered iron core in L1. The latter takes up less room and costs less. A drop of wax will keep the core from turning after the alignment of the amplifier on 28 mc.

A little trick was pulled with the neutralization circuit. I found that the amplifier had more gain and was less critical when I used fewer turns in the neutralization portion of L1 than when I used a center tap. See the diagram for number of turns. Cn may be one or two turns of plastic hookup wire around the base lead. This wire has to go through a hole in the shielding to get from L1 over to the base circuit. With the stage running you will quickly find the part played by Cn. Using all three stages, there will as a rule be oscillation without the neutralization. If you use too large a value for Cn you will only cut the gain a little.

Fig. 2 shows a simple subminiature terminal strip that is especially useful for mounting the *if* coils. Cut small pieces of linen base bakelite as per the drawing and drill .02 holes in it. Use a Variac on your quarter inch drill to slow it down when you do this. You may also have to get a jeweler's chuck to hold those small drills. Then hammer .021 common brass pins into the holes with a light hammer, cement a thin piece of bakelite underneath to keep the heads of the pins from shorting out and see how you like them.

Complete *if* amplifier

The whole *if* amplifier is shown in **Fig. 3.** The slight differences between the different stages are due to the first stage input coming from the mixer, the second stage being a true interstage and the third feeding a diode. The first base input uses the RFC for DC base

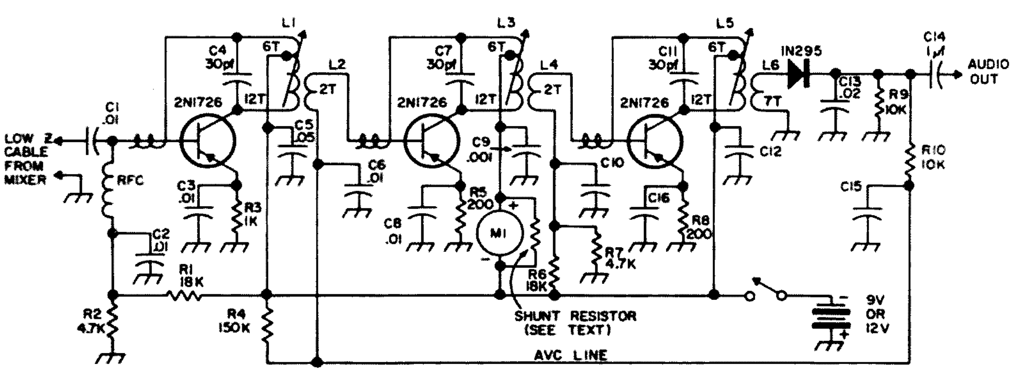
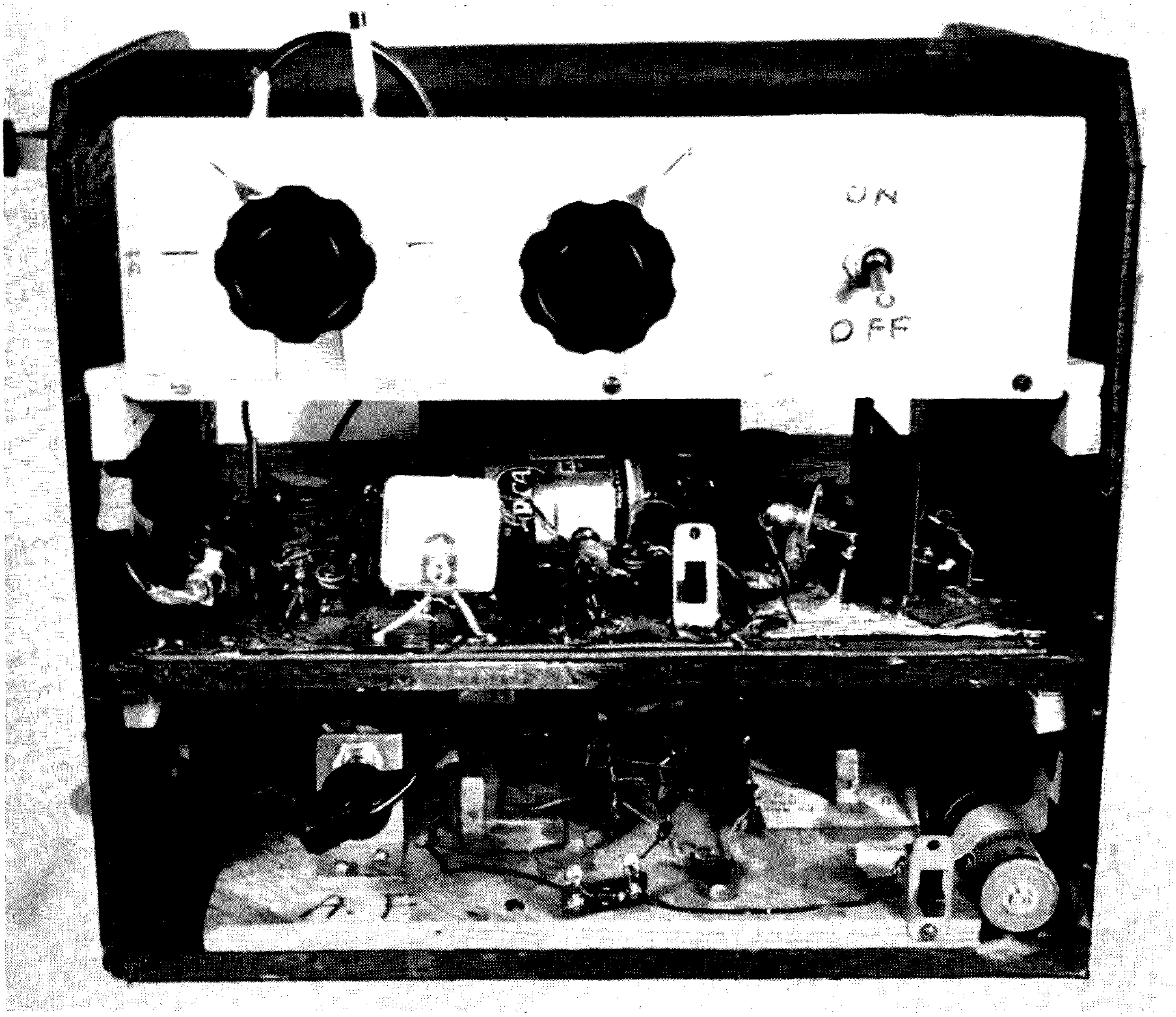


Fig. 3. Three stage 28 mc if amplifier. C10, C12, C15 and C16 are .01 µf.



The complete 1215 mc tunable transistor superhet receiver. The rf components are at top, the if in the middle and audio at the bottom.

security because of a possible open or short of the DC circuit when used with different cables or inputs. The second and third stages do not need rf chokes. L6 feeds the diode, a Sylvania 1N295, which demodulates the signal and also furnishes AVE voltage. A word here about AVC for transistors is needed. In the straightforward circuit used here a balance between diode bias and the *if* stage base bias must be maintained. This balance requirement is the result of the base bias voltage needed, and the diode, which does *not* need any bias other than that which it develops itself from the signal. Several published circuits did not perform well at all in this respect. Using 150 k for R5 leaves the DC

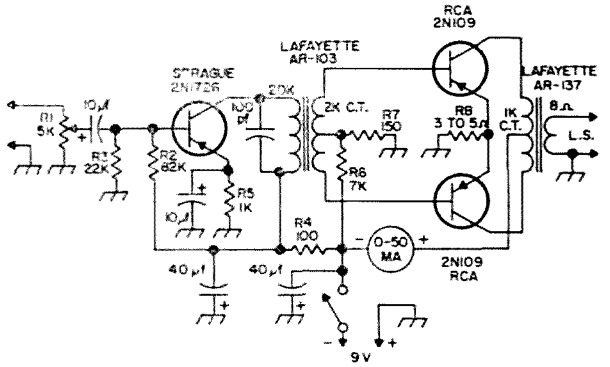
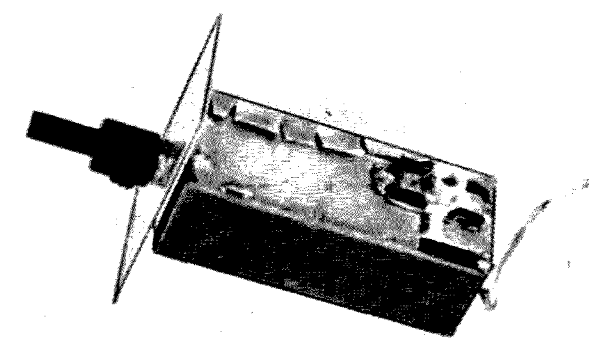


Fig. 4. Audio amplifier for the 1215 mc superhet and other uses.



The 1215 mc local oscillator described in part II of this series.

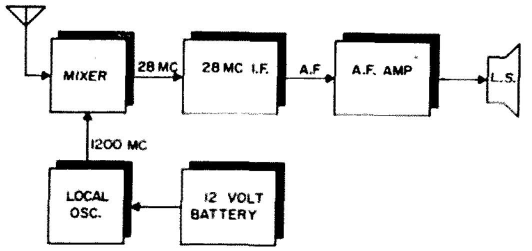


Fig. 5. Block diagram of the complete UHF receiver.

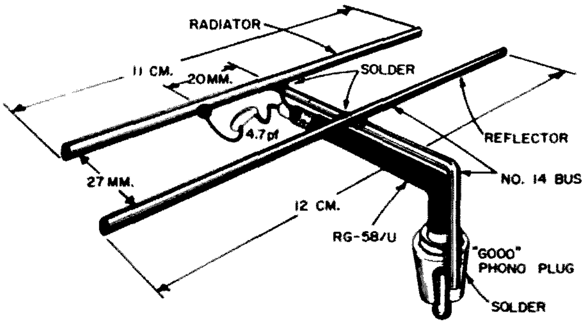


Fig. 6. Two element 1250 mc test antenna.

base voltage flexible and 10 k for R9 allows the diode a stiff control of that voltage. This circuit works fine as is with AVC control of the second stage only. I use a 1 ma meter in the collector supply for an S meter, shunted down with just enough resistance to read near 1 ma with not signal. I would suggest a good large meter with correct swing damping and possible a jack and plug, if you intend to use it for much antenna work with the receiver.

For alignment I used the 28 mc modulated transistor oscillator described in part II of this UHF receiver series. It was slid into a piece of waveguide (drainspout) 4½ inches wide, 2¼ deep and 2 feet long, making an excellent infinite attenuator. The usual $29 to $49 signal generators work all right for frequency determination, but as you probably know too well, they are no good for attenuation due to poor shielding, no filters in the power line, etc., on the higher frequencies.

The bandwidth of the amplifier is about one or two megacycles, depending on how you define bandwidth and how you use the amplifier. To sharpen it, you can convert to lower frequencies but it won't work with APX-6's then. To broaden the bandwidth use more stages, more neutralization and shunt resistors across the whole of each L1. My advice is to use **it as it is.**

Audio amplifier

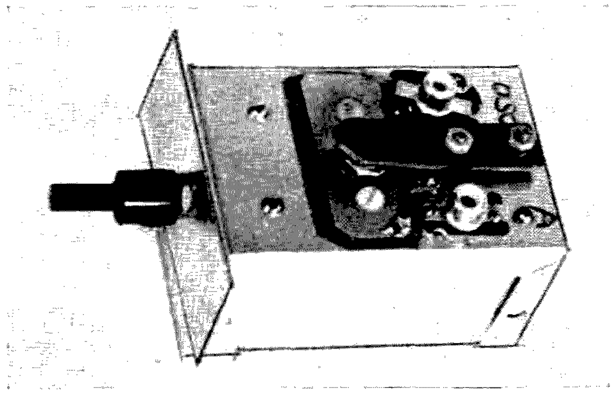
Now for the audio amplifier shown in **Fig. 4.** I'm just going to give the af schematic with practically no talk. After all, you can buy af amplifiers ready made for less than $5. This one has worked well for several years. I built it because I can service it when it stops working instead of throwing it way. Suit yourself. I also use it as a modulator sometimes. R8, the emitter self bias resistor, should be checked carefully as follows: If you go over 5 ohms, distortion will increase, but the current and heating will be less in the 2N109's. As you go towards one or two ohms, more output power and less distortion on volume will be heard but watch out for heat and current creep in the transistors. The original amplifier uses 3 ohms.

Receiver assembly

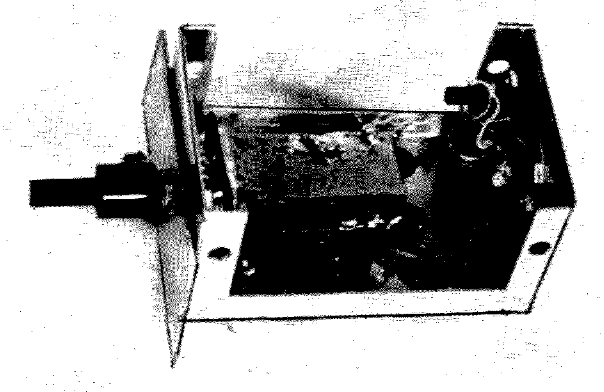
The mixer, local oscillator and battery are mounted on a small aluminum panel on the top shelf. **Fig. 5** shows the block diagram. Not much to it once you've built the units. A low impedance cable connects the mixer to the *if* amplifier, etc. You can, of course, condense this down a lot.

A two element test antenna is shown in **Fig. 6.** For more gain use the one described in the 1215'er article in May '65 73. Be seeing you on 1215.

. . . K1CLL



Outside of the 1215 mc mixer. Note the crystal holder between the oscillator and antenna jacks.



Interior of the 1215 mc mixer described in part I of this series.

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Put Your SB-33 on CW

If you are one of those happy SB-33 (or SB-34) owners, chances are that you have regretted, at one time or another, the no-CW feature of your rig. If, on the other hand, you are contemplating the purchase of this little rig, but you are hesitating because of that same feature—hesitate no more!

The SBE transceiver model 33 can be put to CW use very easily. Less than one evening's work will do it. The same probably applies to the SB-34 and is even more worthwhile since it covers a part of the CW segment on all four of the available bands instead of just the 40M Novice portion. The CW "generation" described below may not be too orthodox and measurements have not been made to determine whether or not the transmitter remains within allowable power ratings, but the rig has been operated many hours in this fashion for more than a year and no trouble of any kind has developed. Reports on the air have been favorable without exception, including those obtained when specific queries were made as to keying characteristics, back wave, and such.

Following is the long list of needed items:

(a) one code key with normally-closed (NC) contacts[1].

(b) a length of something like RG-196/U coax; not more than 3 ft.

(c) one each ultraminiature plug and jack; Allied Radio 42H556 (45¢) and 44H995 (27¢)[2].

(d) an inch or two of #22 solid copper wire.

Take the chassis out of the case and carefully drill a hole into the front panel of 0.19 inch or 5 mm diameter. Locate the hole in the free space (check inside too!) bounded by the 3-position mode switch knob, the upper edge of the panel, and the meter. Now, don't lapse into convulsions just cuz it said "drill into the front panel"! The hole is quite small, and the jack to be inserted is indeed ultraminiature and will just about not be noticed. While drilling, do not allow metal chips to fall into the wiring. Insert the jack and don't overtighten the mounting hex nut. Connect and solder a short wire *directly* from the "hot" jack terminal to the lug on the front wafer of the mode switch that represents the junction point of one 180 pf capacitor and two 3.3 k resistors (the other end of one resistor is grounded and the other resistor ties to diode CR-5); see SB-33 schematic. This takes care of all the rig modifications.

Now connect the NC contacts of your key to the plug using that RG-196/U or equivalent, so that the key armature ties to ground, that is the sleeve of the plug. The partial schematic then looks like so:

Since an SB-34 diagram is not available to me, a short explanation of the principle of the modification is presented in the hope that also SB-34 owners will be able to convert their rig to CW use. All that hte modification, or better "addition," consists of is that the "measured amount of carrier inserted into the load resistor of the CR-5 Sideband Selector Mixer" is shorted to ground by the NC key contacts. Only when the key is actuated (with the mode switch on TUNE), is this carrier allowed to get into CR-5 and thus put a signal on the air. By the way, do not use any type of key click filter, the obvious reason being that you are keying RF and not DC.

To operate the rig on CW, tune the transceiver as before. Insert the key plug into the CW jack just installed. Place the mode switch to TUNE, and start on your first SBE CW QSO![3] . . . WA6PGA

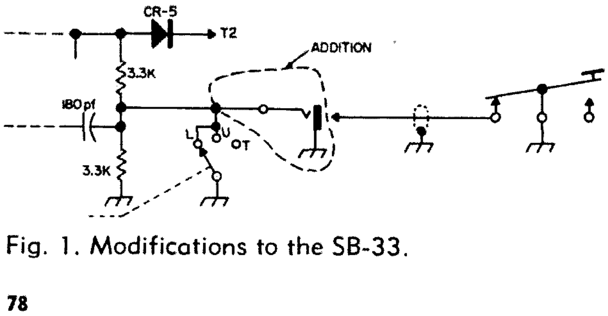
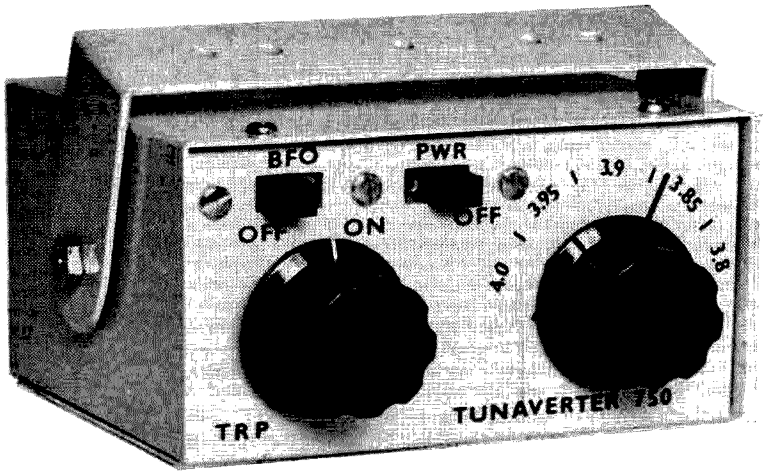


Fig. 1. Modifications to the SB-33.

1. If no NC contacts are available on your key, use the NO contacts to key an appropriately fast relay and use the NC contacts of the relay to key the rig. I'm using an electronic keyer operating into a C P Clare & Co mercury-wetted contact relay HGS-1009 which opens and closes within less than 3 msecs; you don't have to get quite that luxurious!

2. If the jack has an internal normally-shorted contact arrangement, be sure to permanently disable this shorting feature when the plug is removed (or your carrier will be shorted to chassis whenever you are on TUNE with plug removed).

3. A similar scheme to put the SB-33 on AM was in the February 1965 73.



73 Tests the Tunaverter

What's a Tunaverter? If you don't know, you haven't been paying attention to the ads in 73. It's a tunable transistorized converter made by Tompkins for just about any range you could want. Tunaverters are available for the 2-3 mc marine band, 160, 80, 75, 40, 20 and 15 m, and for 14-18 mc for short wave broadcasters (or VHF *if* use). The ham band ones are available with BFO's if desired. Another Tunaverter covers 37-50 mc for police and other utilities with 10, 6 and 2 m models coming up soon.

We received a model 800 Tunaverter for test. It covers 3.5-4.0 mc and has a built-in BFO. The circuit is quite simple. It's a one transistor autodyne converter with ganged tuning of the antenna and oscillator. The BFO is also tunable and uses another transistor.

Perhaps I've become a bit spoiled with all this complicated equipment around, but I really didn't expect much when I connected the Tunaverter to a little transistor radio using the recommended procedure (wrap a few turns of wire around the radio for coupling to the loopstick). After all, what can a one transistor converter do? I connected a short length of wire to the antenna jack—a terrible mismatch—and turned it on. The results were really quite amazing. The combination pulled in all sorts of 75 and 80 m stations and the planetary tuning was very smooth. Turning on the BFO partially blocked the transistor radio so that I had to turn up the volume, but even so, SSB and CW stations were very easy to tune and were received strongly. I then pulled apart the transistor radio and shorted the AGC and the results were excellent. Terminals are provided for this in the Tunaverter. The Tunaverter is stable, too.

Of course, the Tunaverter is really made for automobile use and a typical car radio is far better than a 6 transistor $6 portable. The Tunaverter has a special gimbel mount for installation in a car, and the circuit includes switching for connecting and disconnecting the converter from the car radio. It's made for 50 ohm input and has separate antenna connectors for the regular car radio and your ham antenna, but as you can tell from the above, worked well even with a short piece of wire or with a car antenna.

A feature of the 80 meter model without BFO (number 80) is that the *if* output is 550 kc so that it is perfect for novice CW use with a BC-453 Q-5'er. It would take a very good (and expensive) receiver to beat this combination for 80 meter Novice use.

The Tunaverter is 4½ x 3½ x 2¼" and has an attractive gray case with black knobs and lettering. The 9 volt battery fits inside and muting terminals are provided for use with a transmitter.

Tunaverters are $19.95 up and there are so many models that you really should get a data sheet. The converters are well made and perform excellently. For more information, write Herbert Salch and Co., Woodsboro, Texas.

. . . WA1CCH

T. O. Wallis WA5DEL
Midland, Texas

How to Be a First-Class Lid on Phone

Without really trying

"LID"—a term used in amateur radio to denote a poor operator; one who is inept at the practice of the art.

Lids come in all sizes, shapes, and fashions. Some are beginners, with tickets brand-new; others have been cluttering up the airways since the infancy of amateur radio. Some incorporate only an occasional "liddism" in their radio operating practice, some are moderate and tolerable, while some few seem to work at it full-time.

The term "lid" in its original connotation was coined in the early days of amateur radio to describe the CW operator who was sloppy and careless in the formation of his characters, but nowadays in the phone bands the meaning of the term has been broadened to cover a multitude of other operating sins. This article attempts to deal only with liddisms of the spoken word, and not with other operating malpractices.

A first intimation that you are about to meet a lid on phone dawns when your conversation on the air is interrupted by a voice calling "break, break, break, break, break, break," very rapidly, a half-dozen or more times, usually with no identifying call sign given. I usually don't give this bird an opening at all; I let him wither on the vine, hoping he'll go somewhere else on the frequency to pester another operator and leave me alone.

Perhaps the most irritating lid is the operator who repeats back to you the gist of your previous conversation before going on with his own remarks. This practice always reminds me of the cow re-chewing a regurgitated cud. I get up on the edge of my chair and grip whatever is handy until the white shows on my knuckles when this lid comes along.

Still another liddism, and probably the one most commonly encountered on the phone bands, is the practice of the operator who engages in long, windy monologues, beating his gums on and on, ad infinitum, repeating himself several times and seeming not to know how to shut up and let someone else talk.

I can't tolerate this type of operator; he sends me walking off into the other regions of the house, muttering about giving up my ticket, smashing my receiver, etc. He is apparently a compulsive talker and lacks the ability to relinquish the mike. I suppose he must feel that, if he ever turns the mike loose, he'll never get a chance to talk again, so he has to say it all while he's got it. And say it all he does—not once, but usually several times, repeating himself over and over.

This operator, as much as any other single factor, drove me from AM to a KW Sideband; when this fellow turns up in a round table, I just talk right through his filibuster. Fortunately, most other sideband operators don't like this fellow either, and several have been broken of the habit when they realize they're being talked through on their filibusters.

Inanities and just pure drivel make up a lot of the liddisms one hears on the phone bands. When I hear an operator state that he is going to "turn it over" or "ship it back" to another station, with so-and-so "in the side pocket," I gnash my teeth in anguish. Another hackneyed term is "fine business"; for the lid addicted to its use, everything is "fine business," from the beginning signal report to the final "73," ad nausea. How this one got such universal acceptance by the lid fraternity is beyond me.

Another bit of lid drivel is the practice of giving one's name phonetically when it is a common, easily understandable name to begin with. For instance: "The handle is John—J-O-H-N, Jonathan, Oscar, Henry, Nancy." Or another one: "Bill—B-I-L-L, Baker, Ida, Love, Love." For Pete's sake, fellows, don't you realize that if your listener can catch those

cotton-picking phonetics, he can understand your name in the first place, and the phonetics are a bunch of tommyrot?

I am also shook by the lid operator who, when he has said something he believes to be funny, supplements it with the word "ha," and then laughs in addition. You'd think he would realize that the two mean the same, and the use of both together is redundant.

Finally, have you heard the jerk who calls CQ a dozen times, then gives his call eight to ten times, then calls CQ another dozen times, then announces he's standing by? My reaction is to wonder just what he's standing by; he should be exhausted and in dire need of lying down to rest after the expenditure of that much energy. Seriously, such a long CQ call when the band is open usually results in a half-dozen or so fellows answering at once, on top of each other, and the resulting QRM is so bad that the lid who called can't separate the answering stations. He has defeated his purpose with the long CQ, and would have been much better off, along with everybody else on the band, to have given a series of short calls, with listening periods in between.

There are many other phone band liddisms in current practice. We have all been and still are addicted to the occasional practice of them to some extent. I catch myself in a recognizable liddism frequently, and no doubt engage in many which I don't recognize but which irritate my friends in much the same manner in which the ones here listed irritate me. The ones I've written about are by no means all, and you, gentle reader and amateur operator/listener, will no doubt be able to add many more to the list.

I am not deluded into believing that this article will have any effect whatsoever on lid operations on the phone bands. Each of us will be quick to recognize that old Joe Blow, or old So-and-So, has this or that fault, but very few will admit, even privately, that we are guilty of any liddisms in our own amateur practice. So the liddisms will continue to flow, and I will continue to grip tightly whatever is handy and the veins will stand out on my face and I will mutter profanely under my breath (to keep from tripping the vox), and you will do the same when I commit a liddism, and we will all continue along in our same old merry way. The leopard doesn't change his spots overnight, and neither will the amateur fraternity change its operating habits. So—shipping it over to you, gentle reader, with old So-and-So in the side pocket, this is . . .

. . . WA5DEL

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Some Ideas on Noise-Free CW Reception

The pursuit of single-signal cw reception has generally lead to the use of highly selective *if* and af filters. Unfortunately, the use of sharp filters inevitably results in severe signal distortion, since the shortest rise time a signal may have in order to pass undistorted through a filter is equal to the reciprocal of the filter bandwidth. Because the maximum rise time of a signal at 455 kc is about 10 microseconds, a filter that would pass it without distortion would have to have a bandwidth of at least one megacycle! As the filter bandwidth gets narrower than this minimum, the filtered signal becomes less and less intelligible. The primary deterioration a signal suffers in passing through a narrow filter is called ringing. This effect is caused by the originally square edges of the cw wave becoming sloped by the filtering action. The dits and dahs then become less distinct and melt into a hollow mush.

In a recent article,[1] W6OI revived a much-neglected technique which permits single-signal cw reception without the destructive ringing and background hash that usually results from the use of a selective filter. The idea is to use the receiver audio output and to key an outboard audio oscillator. This oscillator follows the received cw signal, providing the listener with a crisp clean signal free of distortion and background noise. The way W6OI does this is to hang a 1 kc filter followed by a 1 kc tuned audio amplifier on the receiver audio output. The rectified and filtered output of this tuned amplifier is then used to drive a relay to key the audio oscillator. However there are limitations in W6OI's method, basically due to his use of a relay and its associated circuitry to key the audio oscillator. Relays are subject to a hysteresis effect, which means that it takes less voltage to hold a relay closed than it does to close it initially. A look at the sensitive plate relay spec sheets of several manufacturers shows hysteresis effects of 20 to 80 percent. That is, the relay control voltage may have to drop to 20 percent of the value needed to close the relay before the relay will open. In cases of low signal-to-noise ratios the signal voltage may be only a small percentage greater than the noise voltage. So in no-signal periods the noise voltage will be close enough to the noise-plus-signal voltage to keep the relay closed between characters or parts of characters. When selectivity enough to cause ringing is used, the sharp edges of the cw wave are

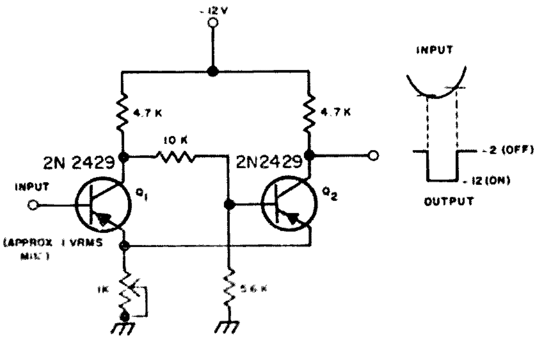


Fig. 1. Schmitt trigger.

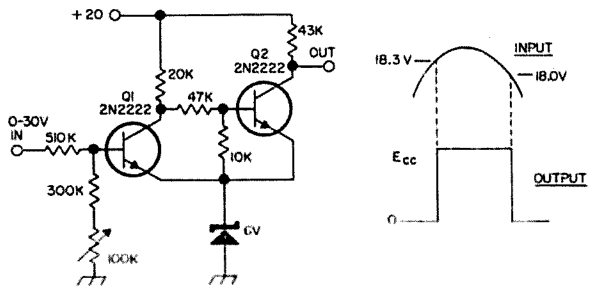
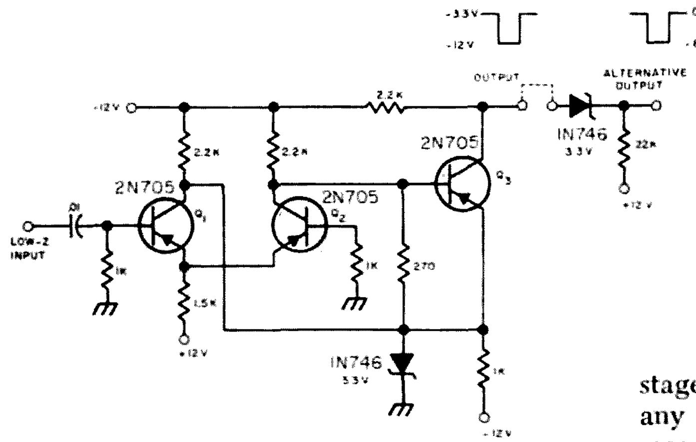


Fig. 2. Using a zener diode to reduce Schmitt trigger hysteresis.



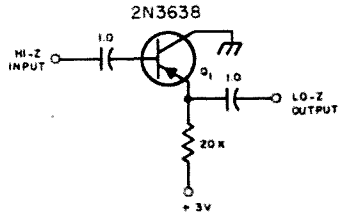


Fig. 3, left. Squaring circuit with no hysteresis. Above, Fig. 5. Emitter follower.

lost, and it is even harder for the audio oscillator to follow the signal. The addition of a dc filter in front of the relay makes a bad situation worse, since it tries to even out the difference in amplitude between the signal and the noise. As the code speed increases, these deteriorating effects cause more and more trouble.

What is needed is an electronic switch to replace the relay. In particular, we want a switch with an adjustable turn-on voltage; we would also like the switch to produce a square output voltage to control the audio oscillator. A popular circuit for switching purposes is the Schmitt trigger. The Schmitt trigger is a bistable amplitude-sensitive device which rests at an "off" output voltage when the input signal is below the turn-on threshold, and flips to an "on" output voltage when the input signal is at or above the turn-on threshold. When the input signal comes back down through the turn-off threshold (usually somewhat lower than the turn-on threshold), the Schmitt trigger falls back to its "off" state. The regeneration of the circuit causes rapid switching between states, which means that the output voltage will have vertical leading and trailing edges. The output wave will also be flat on top, because the input stage of the Schmitt trigger is saturated by any signal above the turn-on threshold. This means that the Schmitt trigger's output voltage is rectangular-ideal for controlling the audio oscillator, as a source of either unblocking or anode supply voltage. The turn-on threshold is set through cathode biasing. By using a variable bias control, the input voltage required to trigger the circuit can be adjusted, providing a means of discrimination against QRM and ringing.

Fig. 1 shows a typical Schmitt trigger. This circuit produces off and on voltages of zero and minus twelve volts, respectively. The switching time is about 12 microseconds at 300 cycles. This trigger is stable from −50 degrees F. to 170 degrees F. There is about a ten percent difference between the turn-on and turn-off thresholds of the Schmitt trigger illustrated. Unfortunately, it is this difference between the thresholds that makes Schmitt triggers only slightly more efficient than relays for our purposes.

The Schmitt trigger's electronic version of the relay's hysteresis can usually be eliminated only at the expense of output wave rectangularity. But Fig. 2 shows how this hysteresis may be greatly reduced without such a sacrifice. The trick is to replace the Schmitt trigger's usual feed-back resistor with a zener diode. The trigger of Fig. 2 has a threshold difference of 4 volts, or more than 22 percent,

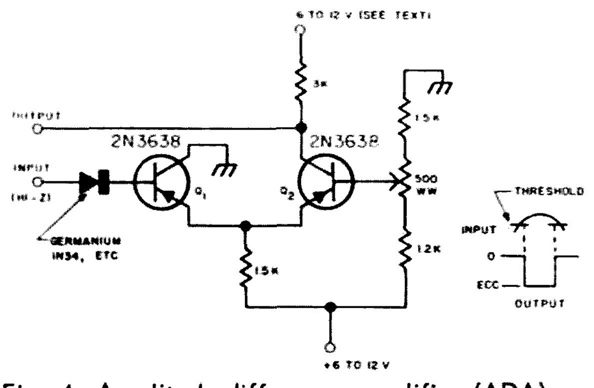


Fig. 4. Amplitude-difference amplifier (ADA).

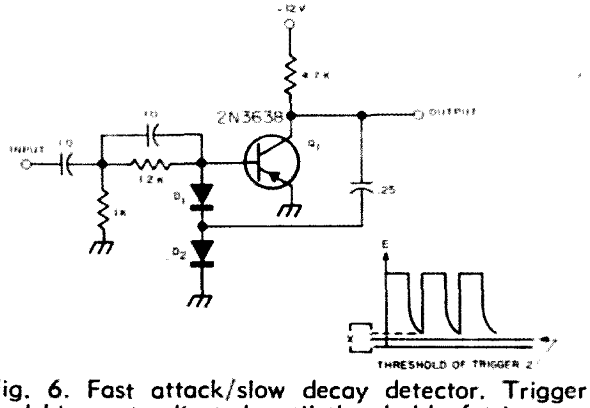


Fig. 6. Fast attack/slow decay detector. Trigger and bias pot adjusted until threshold of trigger a is in region x.

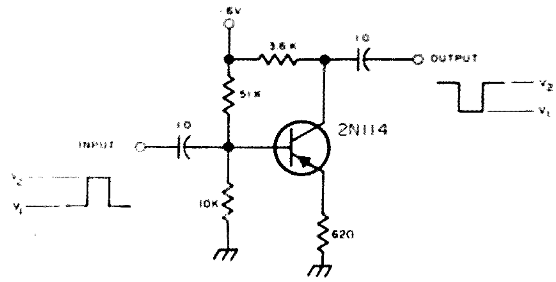


Fig. 7. Pulse inverter.

with the resistor in the circuit. This drops to three-tenths of a volt, or 1.6 percent, when the diode is used instead.

To eliminate this dilemma entirely, it is best to try another switching circuit. Fig. 3 shows one that displays several advantages over the Schmitt trigger. It does not suffer from poor symetry due to hysteresis, and has greater sensitivity (as well as better thermal stability). This circuit consists of a current-mode inverter (Q_1, Q_2) driving a saturating inverter (Q_3). The high degree of sensitivity and stability is due to the symmetry of the inverter. Here, the rise time of the output wave is only 50 nanoseconds.

Another choice might be the amplitude-difference amplifier (ADA) illustrated in Fig. 4. The characteristics of this circuit are similar to those of the Schmitt trigger, except that there is no hysteresis effect. The non-regenerative nature of this circuit results in a rise time of 800 microseconds at 300 cycles. It also has less thermal stability than the previous circuits-performance deteriorates at 140 degrees F. The diode in the base of the input transistor is essential, as the power supply will otherwise be shorted on the negative half-cycles of the input signal. The two transistors to be used here should be checked for beta, and the highest gain unit used as the input transistor. The collector supply voltage would best be chosen with regard to the amplitude of the input signal. If the turned amplifier delivers several volts to the trigger, the collectors should be at about 12 volts; for smaller input signals, 6 volts is better.

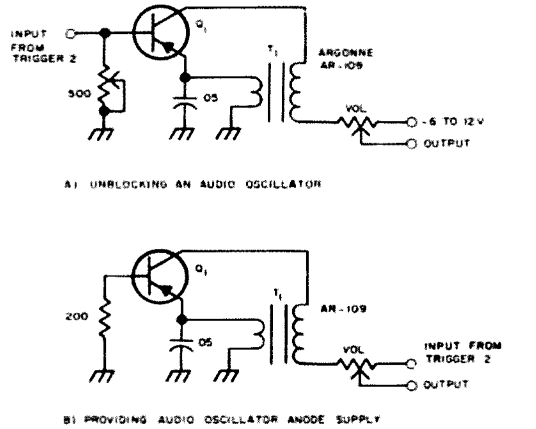


Fig. 8. Using audio oscillator. Q1 is any general purpose PNP transistor with a collector rating of over 12 volts. These are for use with negative going trigger output. Adjust 500 ohm pot in A for correct unblocking action; i.e., oscillation with trigger on and no oscillation with trigger off.

In any of these triggers, the use of a ten-turn linear pot for threshold adjustment will be found to be of great advantage. Also, the components and power supply should have a ten percent tolerance or better. To avoid loading the trigger, it is followed by a simple emitter-follower. Since an emitter-follower operates class A, turn-on time is minimized and transition time is reduced. Thus, this type of circuit will do nothing to damage the fast rise time of the trigger. The emitter-follower drawn in Fig. 5 has a voltage gain of .9 due primarily to the transistor base-to-emitter drop, but it has a current gain equal to the transistor beta/alpha ratio. The power gain from the follower is then considerable.

Since the input to the trigger is an audio sine wave, the output is a string of square waves at the same frequency. Applying this directly to the audio oscillator would result in an audio tone very uncomfortable to listen to. We want to have a dit or a dah come ou' sounding like a dit or a dah, not like severa. hundred little tones each a millisecond long. The thing to do is to stretch a dit or dah's worth of little pulses from the trigger into one pulse just as long as the dit or dah. An easy way to do this is to use a fast-attack/slow-decay detector and another trigger. Since hysteresis is not important here, an ordinary Schmitt trigger will do as well as anything. The detector and its associated waveforms

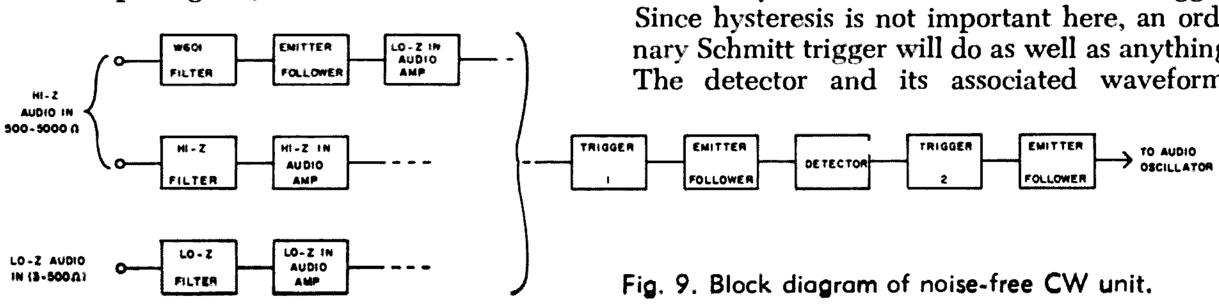


Fig. 9. Block diagram of noise-free CW unit.

are shown in Fig. 6. The detector pulls the trailing edge of each pulse over into the leading edge of the following pulse, bridging them together at their bases. These go into a second trigger with its threshold adjusted low enough to be in the bridged-together portion of the detector output wave. This trigger then produces a pulse that is almost exactly as long as the original dit or dah. The slight hang-on at the end will be no longer than one-half cycle of the input signal to the first trigger. This second trigger's output voltage is then applied through another emitter-follower to the audio oscillator. If a positive-going signal rather than a negative-going one is desired for this purpose, a suitable inverter is given in Fig. 7.

The incorporation of all this into a noise-free cw unit is quite straightforward. The audio input may be taken from the receiver either at a low impedance point such as the speaker terminals, or at a high impedance point such as the earphone jack. The major consideration involved in the organization of these circuits into a complete unit is impedance matching. The receiver output impedance must match the filter input impedance; the filter output impedance (usually the same as its input impedance) must match the audio amplifier input impedance; the amplifier output impedance must match the trigger input impedance; the detector output impedance must match the second trigger input impedance. To prevent loading a trigger or to provide a low-to-high impedance transition, an emitter-follower may be used. To go from high to low impedance, the circuit of Fig. 5 is appropriate. Filters and audio amplifiers with the desired characteristics can be found in the Handbook, semiconductor reference manuals and ham magazine articles.

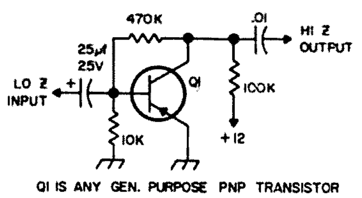


Fig. 10. Low Z to high Z adapter.

Operation of the noise-free cw unit is as outlined in the W6OI article, but if the device is to be used in situations of low signal-to-noise ratios, heavy QRM, ringing, and high cw speeds, performance of this version will be far superior to that obtained from the W6OI version. Here, the receiver's selectivity can be fully used and augmented without adverse effects on the quality of the signal.

. . . K4DAD

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The Crystal Decade

Crystal controlled output at any frequency is possible with this simple frequency-generating system.

The virtues of crystal control are equally appreciated by the scientist who has had to constantly correct the frequency of an expensive self-excited microwave generator or by the radio amateur who has patiently followed a single-sideband signal, wandering jauntily through the spectrum.

In addition to the self-excited oscillators vulnerability to changes in temperature, humidity, barometric pressure, voltage regulation, component and shielding aging, it must also be protected from variations in loading, by isolating buffer stages. Also, its output must be low, for best stability, and this must be built up to a useful level, through the use of suitable amplifiers.

These are only a few of the problems facing the designer of a really stable self-excited oscillator, but will give a general picture.

Crystal control of a generated frequency avoids most of these difficulties, and adds the advantages of short warmup time, less buffering and higher output.

Throughout the years, various methods have appeared to vary the oscillating frequency of a crystal over a limited range. These have included the introduction of an inductive reactance in series with the crystal and an adjustable capacitive reactance across this combination.[1]

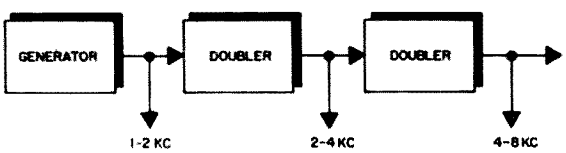

Fig. 1. Using a 1 to 2 range generator and multipliers to produce any frequency.

Satisfactory results over a narrow band are possible, however, as the frequency of oscillation departs appreciably from the crystal design frequency, stability becomes more and more dependent upon the stability of the reactances causing this departure. The temperature and humidity effects creep in again, to modify the inductance and capacitance values and consequently deteriorate frequency stability.

Stated another way, as the crystal is pulled away from design frequency, the order of stability gradually departs from crystal quality and approaches self-excited quality.

The system described here utilizes this method in a very moderate degree, and draws upon other means to achieve the rather ambitious results claimed in the subtitle of this article.

To produce continuous coverage by use of any generator, plus multipliers, the oscillator should have a tuning ratio of 2-to-1. This simply means that the highest frequency produced is twice the lowest generated frequency.

When this is provided, any higher frequency is possible, by use of appropriate multiplier stages. This is illustrated by the block diagram in **Fig. 1.**

The idea of the crystal decade was conceived one day, while admiring the precision built into some laboratory resistance decade boxes. It was noted that the same resistors

were used over and over in varying combinations, to achieve continuous coverage of a wide range of values. The same basic arrangement, using crystals, is the subject of this article. A "coarse" decade of crystals spaced 100 kilocycles apart, also a "fine" decade of crystals spaced 1.8 kilocycles apart is used. A "vernier" control is provided to reach any point between the 1.8 kilocycle values.

Basic elements of the system are depicted in the block diagram in **Fig. 2.** Choice of a low frequency range, will result in fewer crystals being required for the "coarse" decade. A range of 1 kilocycle to 2 kilocycles would be an economical choice.

Oscillator B utilizes the familiar FT-241-A low-frequency crystals, popular on the surplus market. These are spaced approximately 1.8 kilocycles apart and are used without modification. A continuous series of crystals, covering the range of 400 to 500 kilocycles was used.

Synthesizers requiring fewer crystals have been described[2], however one aim here was to use units which were already on hand.

These low-frequency crystals which were so popular in early sideband generators have now been retired by higher-frequency filters. Complete sets of these excellent low-frequency crystals were bought for five dollars, and are now gathering cobwebs in many shacks.

The outputs of oscillators A & B are combined in mixer C, and their sum frequency is selected by the mixer plate tank. At this point in the description, a crystal-controlled output is possible every 1.8 kilocycle point, by switching in each low-frequency crystal. For example, if oscillator A output is 3500 kiolcycles and oscillator B output is 400 kilocycles, mixer C output is 3900 kilocycles.

In order to produce any intermediate frequency between the 1.8 kilocycle values, the medium-frequency crystal oscillator is made variable over the limited range of approximately 925 cycles. Thus the gaps are closed, and continuous coverage is achieved.

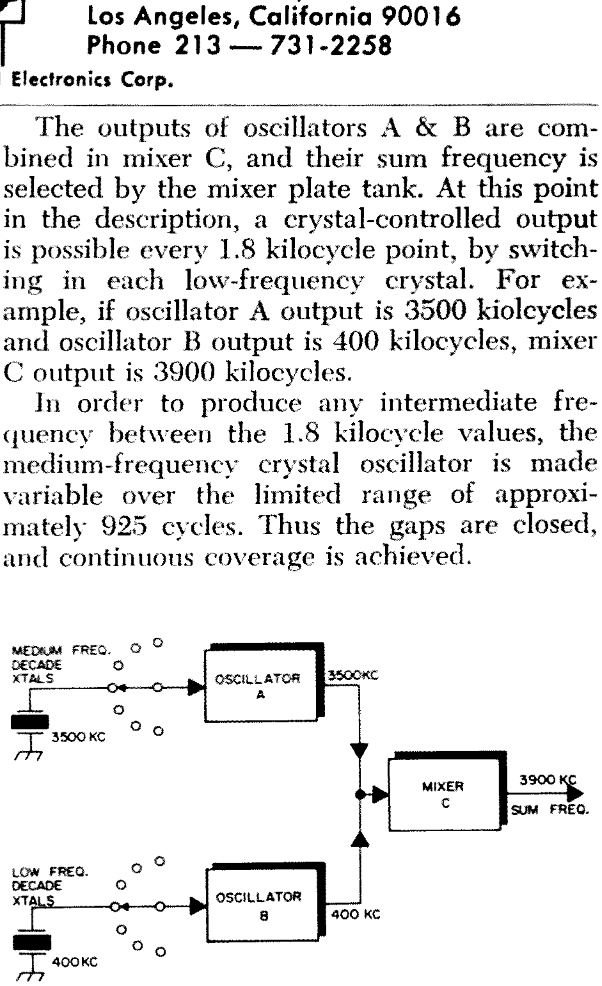

Fig. 2. Example showing how 3900 kc is generated.

Experimental generator

To explore these theories, a working prototype was assembled, based on the schematic of **Fig. 3.** The 6AG7 tube was selected for the oscillators, due to its excellent internal and external shielding and low drive requirements.

The metal envelope 6L6 was selected for shielding and also to probe the possibilities of producing sizeable power output with a minimum of stages. Conventional components were used, and no critical adjustments were encountered.

For the "coarse" decade, type FT-243 crystals were etched to frequency, using the method described in a previous article[3].

The low-frequency oscillators is conventional, with the value of C4 determining the amount of feedback. Transformer T1 in the plate circuit provides matching and isolation between the oscillator and mixer.

The medium-frequency "coarse" oscillator circuit also contains the "vernier" frequency control C1.

The mixer is fed medium-frequency rf at its control grid and low-frequency energy at its screen. This circuit provided more output than any of several other arrangements tested.

Adjustment

Tuneup of the oscillators is facilitated by use of an rf indicator. Small neon lamps, temporarily soldered to each tube plate terminal, served nicely.

Once satisfactory operation of the oscillators is obtained, transformer T1 should be tuned for uniform output over the 400 to 500 kilocycle range. If necessary, one winding may be peaked near 425 kc and the other near 475 kc. All other adjustments are for maximum output.

It would be wise to calibrate at least roughly, the tuning dial of C3, to avoid selection of an undesired output frequency. This may be easily done by temporarily removing the low-frequency oscillator tube and driving the mixer with the medium-frequency oscillator alone, using crystals covering the desired output range. The mixer output is peaked for each crystal, and C3 dial is labeled to correspond with the crystal frequency marking.

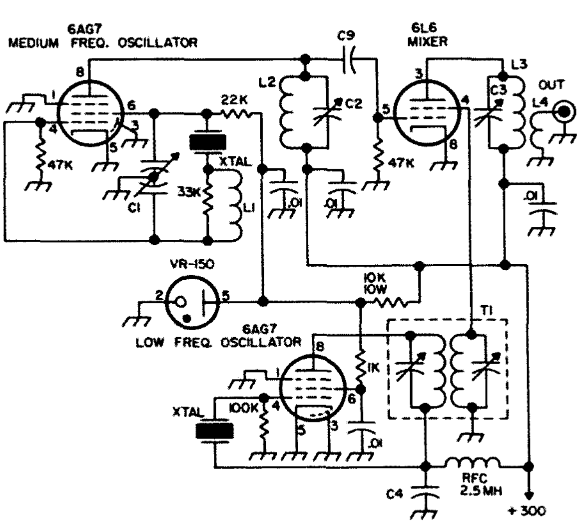

Fig. 3. Crystal Decade Frequency Generator. Components are chosen to include the 80 m amateur band in the generator range.

Operation

To select any frequency, the next "coarse" decade crystal below the desired frequency, is selected. Next, the "fine" decade crystal producing the lowest beat tone in the receiver, is switched in. Last, the exact frequency is "zeroed in," using the "vernier" control C1.

Notes

In the prototype, simple, single crystal sockets were used. A finished product should incorporate a convenient switching system for the two crystal decades, preferably coupled to a digital type dial.

The prototype described has been used as a transmitter on the 80 meter band for six months, with excellent stability reports. No change in the frequency of either oscillator is detectable when the mixer is keyed.

Excellent break-in cw characteristics may be achieved, by thoroughly isolating through the use of shielding and adequate bypassing. Under these conditions, no output will result until the mixer is keyed. If just the popular amateur bands are to be covered, using multipliers, only five crystals will be needed in the "coarse" decade: 3100, 3200, 3300, 3400, and 3500 kilocycles.

With reasonable care during construction, a really stable frequency generator which is a pleasure to hear, will result. . . . W4ATE

[1] Shall, "VXO—A Variable Crystal Oscillator" *QST*, January 1958.
[2] Briggs, M. R. and Morrison, H. J. *QST*, January 1964.
[3] Brizendine, G. "Quartz Crystal Etching," Radio & Television News, May 1954.

Parts Table

C1. 50-50 pf dual variable capacitor.
C2. C3. 100 pf variable capacitors.
C4.500 pf mica capacitor.
C9. 1000 pf mica.
L1. 40 turns #22 enameled wire scramble wound on 11/32" diameter ferrtie core, 1" long.
L2. 45 turns #22 on ⅞" form.
L3. 27 turns #18 on 1-5/16" form.
L4. 5 turns #18 wound over ground end of L4.
T1. 455 kc air tuned *if* transformer.

NEWS FROM THE INSTITUTE OF AMATEUR RADIO

Compiled by A. David Middelton W7ZC, Secretary

IoAR membership

The success of any group activity depends upon its membership and leadership! IoAR is bound to succeed if a sufficiently large number of amateurs will accept the Institute's concepts and if they will join, work for and with IoAR and support its ideals—and ideas.

Membership is recruited from the ranks of all who have a bonafide respect for and sincere interest in amateur radio.

IoAR must have a *large membership*—and is seeking them in the vast majority of amateurs who have *not* found what they were looking for, even if they are or were, members of some other national organization!

Membership and support of at least one national amateur organization should be a "must" in the "design specifications" for an active, participating amateur!

More than *two thirds* of all the American amateurs have *not* found what they desired, or have felt they were *not* being properly represented. It is to those Amateurs who are not satisfied, that IoAR offers the greatest appeal and an opportunity to belong to a group they do believe in—and wish to support!

IoAR must have many thousands of members if its realistic and logical program is to be accomplished. This membership must be gained quickly and without delay—if the Institute's intriguing program is to be placed into effect.

IoAR's strength and bargaining power (a phase now understood and respected in all circles) depends upon the Institute's *numerical and political* strength and the integrity of its leadership.

What do *you* get for your IoAR membership dollars?

First, you get a membership card and certificate, an IoAR button and a supply of IoAR stickers.

Second, your membership dollars will provide you with a "pass" to what may be the biggest Donnybrook in the history of Amateur Radio! The Founding Members of IoAR are not naïve. They are fully aware that the founders of IoAR, the Institute membership, IoAR's columns in 73, even the basic concepts of IoAR will be the target of a terrific barrage attack!

The Institute has no intent or money to stage a war! We plan to put all the possible effort and resources, gained through membership income, or other IoAR-secured funds into *furthering* the *ideals* and *ideas* of IoAR, *not in waging a WAR!*

Amateurs who have given any thought to the conditions that have existed for far too many years know full well that the American radio amateur has been cleverly brain-washed into believing that there could be only ONE national amateur radio organization.

Even to hint of the possibility of "another group" arising and having the temerity to "represent" some portion of Amateur Radio, is and has long been tantamount to HERESY—or worse!

"Don't rock the boat!" is a cry that goes back into the '20s. Perhaps if the "boat" had been rocked a bit more, some of its occupants, too long in power, would have been tossed out, and replacement made with persons more conscious and considerate of the wishes, needs and importance of true representation of the amateur body politic!

Therefore, IoAR extends to you, through membership, a chance to a part of a bold, vitally NEW CONCEPT in *representative* amateur radio. It is your opportunity to help form a NEW and POWERFUL force for good in your chosen hobby!

IoAR—Totally Dedicated to the Betterment and Preservation of Amateur Radio.

Third—your IoAR membership is your "ticket" thru the gate of opportunity to DO something—you, Mr. Joe Q. Ham, for your *interests in your own hobby!*

IoAR will need many "workers in the vineyard"—persons who are unafraid of work, struggle, criticism, ridicule, and even defamation of character!

IoAR must have member-amateurs who will offer and give their valuable and varied services to help build the Institute into an overwhelming power that will restore and add dignity to amateur radio. IoAR will find a place for your talents!

Fourth—your IoAR *membership* permits you to subscribe to 73, at a *reduced* rate, and also allows purchase of 73 manuals and other publications at a 25% *discount.*

Note that IoAR has separated membership fee from any compulsory magazine subscription in the belief and hope that MEMBERSHIP in a national association of Amateurs will *again* become *important* and vital—rather than something one automatically receives when he subscribes to a magazine!

The Institute believes that IoAR can acquire the qualified leadership required to BUILD—and to guide YOUR activities in a forward, cooperative fashion that will enhance amateur radio in all its facets.

IoAR MEMBERSHIP Representation will be the NUMBER ONE task of the Institute. IoAR's income will be ploughed back into its workings and not into a large portfolio of stocks or a fat bank account.

With MEMBERS—the IoAR can DO things! Without membership assets (and membership assistance) the Institute will fail!

You can be a part of IoAR with your effort, unified with that of many thousands of others—you can help make the Institute a potent weapon in the defense and enhancement of amateur radio.

You have now been given the "word". Many of yon have long expressed the desire to DO something. Now is your chance! For the few dollars you can become part of a national movement that just might preserve amateur radio!

Think it over. Is amateur radio worth anything to *you?*. If you are satisfied and content with the present "representation" and status quo— then IoAR is NOT for you!

If amateur radio *does* mean something to you, and is worth fighting for, and if you recognize the need for an *abrupt change* in national amateur radio leadership—and the necessity for more *POLICY* and less politics—then IoAR has a place and a job for you and your membership will let you participate and help!

Buy into this NEW concept—or sit back on your duff, keep your money in your pocket and watch what happens to YOUR hobby in the next few short months.

IoAR is one means of preventing amateur radio from further drifting into a morass of confusion—more "deals" and less frequencies!

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Springdale, Utah 84767

For membership correspondence and IoAR supplies:
Institute of Amateur Radio
Peterborough, N.H. 03458

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Institute of Amateur Radio
Peterborough, N.H. 03458

Carol Allen K9AMD/W5NQQ
155 Karen Drive
Lafayette, Louisiana

A Hero of the Ham Bands

Did you ever work a hero on the ham bands? You probably have and didn't even know it, for the airwaves are full of signals from folks who have earned their tickets in spite of illnesses, accidents, and birth defects that handed them crippling handicaps. They neither expect nor want any flag-waving about their accomplishments, but now and then attention drawn to an out-standing individual helps the whole hobby.

Paul Graden K9YMZ, better known as "Deke" around Illinois and neighboring states, knows the feeling of triumph over a handicap. A victim of a hereditary eye condition, Deke had to quit his job as a creamery route driver at Nokomis, Illinois, some years ago and drastically curtail other activities, too, as his eyesight failed. Rather than resign himself to an easy chair, he followed the advice of a friend and bought an amateur radio license manual. His instructor was Dan Hoover, W9VEY, of Hillsboro, who dreamed up graphic descriptions of formulas and ways to interpret theory to his student.

Shown with his copying device for code is Paul Graden K9YMZ, known as "Deke," and his wife, Verna.

"Getting a ticket is rough enough for a person with normal vision," said Hoover, "but Deke refused to be discouraged."

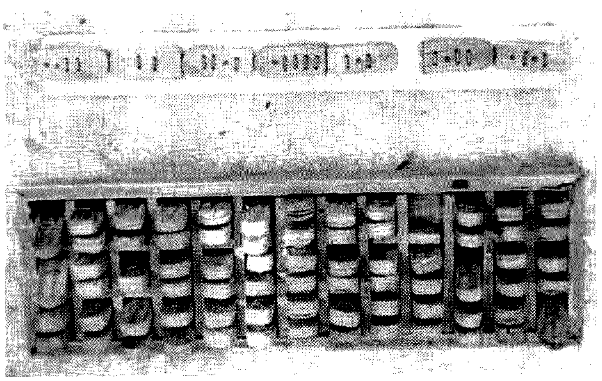
His patient XYL, Verna, attended all his lessons and worked as hard as any prospective ham so she could help her OM at home.

"I thought I had met my Waterloo with the code," Deke recalls, "but I finally figured out some aids that did the trick."

He fashioned his own Braille system in blocks. Cutting small pieces of soft wood measuring 1¾" by ¾" and ⅜" thick, he drove in gimp nails for dits and flat staples for dahs using one block for each letter and number. Arranged alphabetically and numerically in small trays, the nails and staples brought the code alive. While listening to records or W1AW, Deke reached to the trays and found the proper blocks, helping to place the characters in his mind. Although he remembers call letters by the dozens now, he still sets up frequencies, handles, and other pertinent scoop in the trays so that a touch of the hand jogs his memory.

The next hurdle was finding a way to convert the code from mind to paper. This called for another invention, a code-copying device that feeds paper something like a washing machine wringer. Deke writes along the guiding slot and dials fresh paper when the line is full. Now that he copies code in his head, he uses the invention mostly for recording times, calls, and other important information which Verna transfers to the log book when the dishes are done.

Although three other licensed amateurs live in Nokomis, they weren't very active until



Deke got on the air. With a Viking Valiant, HQ-170, and doublet, he works 80 through 10 and uses a Heathkit Two-er for Montgomery County contacts.

"Deke has really put Nokomis on the map," said one of his rag-chewing partners. "It may be a small town but it has a mighty big voice."

Any Hiawatha fan will recall the "land of Nokomis" and Deke's QSL card is complete with Indian brave, teepee, and smoke signals. A QSO with the friendly fellow "in the valley of the moon" leaves any ham smiling, and those who personally know of Deke's courage and accomplishments in amateur radio can't help being proud of him, too.

. . . K9AMD

Amateur Frequencies

At the recent International Amateur Radio Club Convention in Geneva, Mr. D. Schmelling of the German PTT Monitoring Service read a paper on amateur frequencies. Alfred Schädlich DL1XJ, a member of the Editorial Board of IARU Region I Bulletin, who was present, prepared this translation of the paper, which was taken from the IARU Region 1 Bulletin for October 1965.

A point of major interest in your discussions today is the problem of "frequencies"—especially frequencies for radio amateurs—but before going into details allow me to make a few general remarks. The development of communications by means of radio throughout the world, brought about by extensive political, sociological and economical changes, has led to an acute frequency shortage and, consequently, to an increased susceptibility to mutual interferences of the telecommunication carrier—"radio."

Although the International Telecommunication Convention requires:

- an economical use of frequencies and frequency bands,
- a reduction to the minimum of the number of frequencies used for a satisfactory service,
- the operation of all radio stations in such a manner as not to cause harmful interference to other radio stations or radio services,

a number of member countries allow their radio services, occasionally, a rather free interpretation of the internationally-accepted rules, thereby involuntarily causing harmful interference to other radio services. This happens quite often to the Amateur Service as well as to other services. The ITU is deeply concerned about this problem and does everything in its power to alleviate it. Following the Geneva Radio Conference in 1959, a panel of experts was set up and came forward later with a number of proposals showing how the general shortage of frequencies could be reduced somewhat. Time does not permit to go into this matter more deeply here. Our concern in the frequency shortage and usage as far as the Amateur Service is affected. You all know that the congestion on the amateur bands has been constantly increasing during the last few years.

Observation methods

The radio monitoring service of the German PTT Administration is closely following the development in the entire frequency spectrum and in this connection, of course, in the amateur bands, too. Our method of observation is twofold; firstly, the *subjective method* is done manually by operators. It is mostly used to identify an emission and assess its quality. The *objective method* is done automatically by means of apparatus running unattended over specified periods. This method allows us to record the frequency of an emission, the time of occupancy, the bandwidth and, if desired, the automatic recording of the signal-to-noise ratio. Automatic observations are obtained by means of a frequency sweep recorder, a special piece of photographic recording equipment called a Frequentophot-camera and frequency-amplitude analyzers. The frequency sweep recorder, which we have developed according to our requirements, is nothing particularly special. Such recorders are universally used nowadays.

Since sweep recordings normally give only general information about band occupancy without showing the finer details, a frequency-amplitude analyzer, with photographic recording facility—was developed. This device, (the Frequentophot) permits us to make

automatic observation of the more important parameters such as frequency, class of emission, bandwidth and signal-to-interference ratio. With the Frequentophot we can easily make wideband sweeps or scrutinize a narrow band of frequencies.

Principle of the device

The signal received by the antenna is passed through an adjustable attenuator to the receiver input. The receiver is automatically tuned by a motor over the band of frequencies to be analyzed. The intermediate frequency of 525 kc is applied to the radio frequency spectrum analyzer. In the r.f. spectograph the signal is converted down to 8 kc and after detection applied to a dc recorder. At the start and at the end of such a recording an amplitude calibration is made by means of a field-strength measurement. This semi-automatic method gives us rather good recordings of any chosen part of the spectrum with adequate resolution.

Band occupancy in Central Europe

Let us now turn our attention to the problem at hand, namely, the occupancy of the high-frequency amateur bands as they present themselves in Central Europe.

(1). "Top Band" (160 m) is not really an amateur band at all. As it may only be used by amateurs of certain countries on a non-interference basis to the Maritime Mobile Service, with rather severe restrictions on amateurs, we can leave it out of the picture.

(2). In Region I the 80 m band is shared with the Fixed and Mobile Services (except Aeronautical Mobile) on an equal-right basis. This equal-right basis is, however, under the present regulations, rather problematic. Whereas frequencies for stations of the Fixed and Mobile Services must be notified to the International Frequency Registration Board and eventually entered in the Master Frequency Record (which gives them a measure of protection against harmful interference), no such procedure exists for the Amateur Service. In fact, the IFRB receives no official information whatsoever as to the number of amateur stations or their modes of operation.

From an examination of IFRB information concerning Fixed and Mobile stations registered to operate in the 3.5-3.8 mc band, we find more than 400 entries occupying a total of 249.85 kc. This means, that a spectrum width of 50.15 kc remains for the Amateur Service but this is, of course, not concentrated in one lump; instead it is scattered over the entire band. This is only the theoretical side of the problem; the practice is worse, when consideration is given to the major operating hours of amateurs. If we look closely at the number of stations officially recorded by IFRB we find that only 70% use their assignment, the remaining 30% are never, or very seldom, heard. Yet the frequency usage is still heavier.

From observations made by my Administration during past years regarding the band between 1600 and 6000 kc, it has been found that per frequency usage *recorded* with the IFRB, a factor of 1.6 to 2.1 *unrecorded* usage exists. In other words if we revert back to the 70% active officially recorded stations in the 80 m band the actual number of non-amateur stations operating there is somewhere between 175 and 217. These are plain figures of stations without taking into account their occupied bandwidth.

Our frequency sweep recordings and the frequency versus amplitude analysis which were made under constant ionospheric conditions on two different week-days show that the peak frequency usage occurs on a week-day (Friday through Saturday) between 14.00 GMT and 04.00 GMT. The week-end (Saturday through Sunday) shows the peak usage between 18.00 GMT and 04.00 GMT in the morning. The amateur operation on Saturday sets in heavily at 18.00 GMT, has its peak one hour later and diminishes after midnight.

In addition to sweep recordings, we have made at three-hour intervals a closer analysis of the spectrum, showing frequency usage and the respective field-strength values. Since a very slow scanning speed was used for the sake of accuracy, no clear indication of the class of emission is given. Our main objective was to show the density of occupancy and the associated field-strength values. The recordings were taken at a scanning speed of about 3 centimetres per minute, the whole recording taking about 10 minutes. By a judicious choice of the scanning speed, the class of emission and occupied bandwidth can also be recorded. The identification of the various types of transmission from such recordings does, however, require some experience.

Another matter may be of interest in this connection is the variation of the general noise level. During daytime this is at 10 db above 1 microvolt per metre and during the night at about 30 db above 1 microvolt per meter at an analyzing bandwidth of 100 c/s.

(3). We come now to 40 meters which is restricted in Region I to the frequency band

7000-7100 kc. Propagation conditions on this band are often of such a nature that it cannot be regarded as a "playground" for the beginners or a "rag-chew" medium for the old-timers as is often the case with 80 m. On 40 m serious amateur work starts. The band is allocated exclusively to the Amateur Service, at least the Radio Regulations say so. The practice is entirely different as we all know. Sweep recordings made on a Friday, Saturday and Sunday show a constantly-increasing intrusion by broadcasting stations which cover nearly the whole band with their occupied bandwidth, and this during hours which are by nature the best operating hours for the Amateur Service (16.00-23.00 GMT).

The most prominent of the intruders squatting constantly in the exclusive amateur band are:

Frequency kc	*Station*	*GMT*
7006	Serrai Greece	0500-1300
		1500-2000
7019	Radio España Independenta	1600-2300
7035	Radio Peking	1500-2100
		2130-2230
7040	Kozani Greece	0430-1730
		1000-1200
		1500-2100
7050	Cairo	0200-2330
7060	Peking	1600-2400
7064	Teheran	0200-0600
		1200-2030
7075	Cairo	0300-0700
7080	Peking	1600-2230
7082	Cedaye Melatte Iran (Albania)	1400-1930
7085	Jeddah Saudi Arabia	1530-2300
7090	Tirana Albania	0400-0700
		1500-2300

Most of these stations operate outside the broadcast bands in blatant disregard of the provisions of the Radio Regulations. Geneva (1959).

If we assume that the bandwidth of these broadcast stations is 9 kc—in some cases it is much wider—we arrive at a total occupied bandwidth of 108 kc. Since there is, however, some overlapping of the broadcast sidebands some small gaps are left free in this 100 kc wide band for its only legal user—the Amateur Service. The casual observer might assume that the programmes are intended only for local or national use but as those transmitted by Radio Peking are beamed towards Europe and those of Radio Cairo to the Middle East it is clear that this is not so.

The number of normal non-amateur telegraph stations heard on 40 m is not high; they do not present a severe problem, though legally they are frequency "pirates" in the same way as the "intruder" broadcast stations.

A further source of severe interference which cannot be passed over lightly are the jamming stations which try, with very high power, to render certain broadcast programmes unreadable. These stations often work simultaneously from different widely-separated locations, spoil with their very bad modulation, wide sections of the spectrum, thus making conditions still worse for amateurs.

Sweep recordings show that, on normal working days, amateurs use the 40 m band only sparsely but on Saturdays, and even more so on Sundays, a distinct rise in occupancy can be seen. Frequency-amplitude recordings taken for comparison purposes on a week-day and on a Sunday show a similar distribution. The general noise level during daytime between 09.00-15.00 GMT was found to be at 0 db above 1 uV/m and during the rest of the time at about 12 db above 1 uV/m taking into account the scanning bandwidth of 100 c/s used. For a receiver operated under normal conditions this would correspond to a noise level of 10-25 db above 1 u/Vm.

(4). In regard to the bands 14000-14350 kc and 21000-21450 kc conditions are much easier to describe. Both bands still enjoy more or less their exclusiveness even if in the 14 mc band occasional stations appear and operate outside their assigned service bands. Frequency amplitude recordings have been taken for these bands supplemented by sweep recordings both for a normal weekday and a Sunday.

(The lecturer then presented a recording showing the effects of a campaign launched by German radio amateurs for the defense of amateur bands. The recording showed the spectrum of a broadcasting station in the exclusive amateur part of the 7 Mc band and simultaneously various stages of a strong amateur signal approaching the center frequency of the "intruder." The lecturer doubted whether this or similar actions will be of value. He agreed there was no evidence that the amateur had intentionally tried to interfere with the broadcast transmission.)

Conclusion

The best defense against intruders into exclusive amateur bands is for amateurs throughout the world to use these bands more fully. Only by the full use of the bands by those legally authorized to use them, will ad-

ministrations or radio services which try to intrude without international right be discouraged from doing so.

The general increase in interference, due to universal frequency shortage, affects, of course, not only the amateur bands. I would like you to take account of this fact in your deliberations.

(The lecturer then showed some frequency sweep recordings representative of many cases of interference noted by the Monitoring Service. The recordings showed an A7B emission in the spectrum of which a broadcast signal was literally ploughing about. Two further recordings showed technical irregularities of the emission which caused harmful interference to other services on frequencies nearby. Also seen was the recording of spurious emissions of an A2/Hellscriber transmission which impaired a frequency band more than 30 kc wide. A further recording showed some trouble on an F1/Morse transmission which for hours interfered with a spectrum width of 5 kc. The lecturer explained that such imperfections did not reflect on the technical standard of the commercial operators concerned, in fact, causes were quickly removed as the result of collaboration by the international Monitoring Services).

Finally allow me to suggest how, in my private opinion, the further influx of foreign stations into the exclusive amateur bands can be brought to a halt.

(a). The ITU might be induced to recommend administrations to carry out a worldwide observation programme of the various amateur bands by using national monitoring services.

(b). The ITU might be requested to analysise these observations (in a manner similar to the analysis made of the aeronautical, maritime mobile and broadcast bands) and then request the administrations concerned to remove radio stations from frequency bands which are not allocated to them according to the Radio Regulations.

(c). If the foregoing proposal is not acceptable to the ITU the Amateur Radio organizations should carry out world-wide observations of the amateur bands. When intruders are found to be operating in exclusive bands the national society concerned should approach the appropriate administration and point out the infringement of the International Convention asking at the same time for measures to be taken to remedy the situation.

NOTE. Copies of the graphs and charts referred to by the Lecturer can be obtained by sending two International Reply Coupons to Mr. Alfred Schadlich, DL1XJ, Post Horn 8, 61 Darmstadt, Federal German Republic.

Richard Van Wickle W6TKA
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Santa Barbara, California

Semi-Modernizing Vibrator Power Supplies

There are probably many small vibrator power supplies relegated to gathering dust on shelves due to the popularity of transistor mobile supplies. Well, dust off those "vibrapacks" because here's a way to get more output from them, thanks to silicon rectifiers and the use of a bridge rectifier circuit.

Our vibrator supply shown in **Fig. 1,** rated by the manufacturer at 300 volts at 100 ma, actually delivered only 265 volts at 100 ma, after filtering. This was obviously nothing that would power a transmitter into generating much excitement on the lower-frequency bands, so we started tinkering.

First substituting silicon rectifiers for the 12X4 tube rectifier, in the same center-tap circuit in which the 12X4 was used, increased the output to 300 volts at 120 ma. Flushed with success and seeking even higher output, I remembered the old idea of increasing the voltage by using a bridge rectifier circuit. Normally, in the case of transformers rated for ICAS (intermittent amateur and commercial service), about all this buys you is doubling the output voltage over the full-wave center-tap circuit, with the requirement that the output current has to be reduced to half of the previous value in order not to overload and damage the transformer. However, most vibrator transformers are rated for CCS (continuous commercial service) and are tolerant of overloading for periods of over 10 minutes and do not get appreciably warmer than when operated in the lower-output, center-tap circuit over the same period.

The modified circuit is shown in **Fig. 2,** and the results have been most gratifying. Typical voltage/current combinations achieved are given in **Table I.** The silicon rectifiers used are rated at 400 PIV at 750 ma, and by careful shopping can often be obtained for as little as 50¢ each.

My modification included the use of a choke input filter rather than the original capacitor input filter. Grammer[1] observed that for the same dc load current the secondary power loss was between 2 and 2.5 times as great with a capacitor-input filter than the loss with the choke-input filter. Thus, approximately 50% more current can be taken from the transformer with choke input than with capacitor input, for the same secondary heating. The problem with choke input is that the output voltage is much lower than with capacitor input, a drawback that is more than compensated for with the illustrated bridge-rectifier, choke-input system.

You have probably by now observed, from the figures and table, that there is another advantage to our modified circuit. The transformer secondary center tap now provides a low-voltage source, suitable for operating speech amplifier stages and rf oscillator and driver stages.

Another advantage you may not have noticed is that it is no longer necessary for the

[1]Grammer, "More Effective Utilization of the Small Power Transformer," **QST,** November, 1952, p. 18.

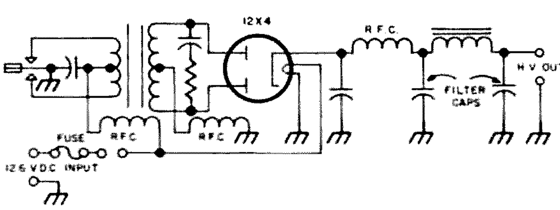


Fig 1 Original 300 volt, 100 ma vibrator power supply circuit.

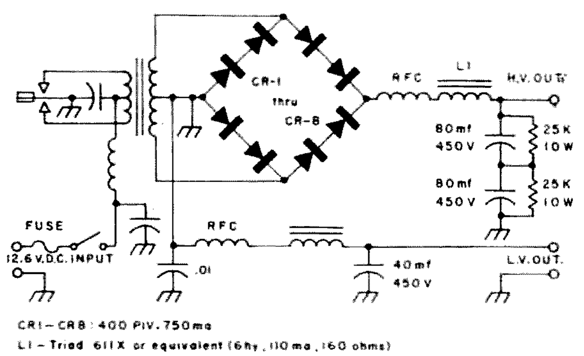


Fig. 2 Vibrator power supply modified for bridge rectifier operation, using silicon diodes. All components for which values are not indicated are same as original circuit.

Table I

	Low B+ Tap	High B+
With 50,000 ohm bleeders on low B+ tap and on high B+; no other load	360	695
Examples of voltage/current combinations	215 v @ 25 ma	425 v @ 90 ma
	200 v @ 55 ma	410 v @ 85 ma
	175 v @ 35 ma	350 v @ 145 ma (See Note 1)
	185 v @ 70 ma	400 v @ 90 ma

Note 1: At this condition, representing highest total power output of any conditions shown, total battery drain (at 12.6 volts) is 6.5 amperes. Efficiency approximately 70%.

vibrator supply to run continuously. The silicon rectifiers allow the supply to be keyed on and off with the push-to-talk circuit of the transmitter, and battery drain is kept to an absolute minimum. (My mobile converter uses tubes of the "hybrid" type, designed for 12.6 volt filament, screen grid and plate operation, and the total drain of the converter is only 400 ma!)

From Table I it can be seen that it is possible to draw as high as 50 watts from the high-voltage tap 200 volts at up to 35 ma—a big improvement over the less-than-30 watts total power available with the former tube rectifier, center-tap circuit.

. . . W6TKA

Denys Fredrickson WØBMW
3923 East Funston
Wichita, Kansas

Use Your GDO and Z-Meter

The GDO is one of the most versatile pieces of test equipment available. Yet there are many hams who don't know how or when to use one. The writer will try to describe and explain some of its various functions.

The GDO is basically a variable high frequency oscillator with a frequency range of approximately 550 kc to 250 Mc. It may also be used as a diode detector or wave meter. The GDO gets its name from the fact that a meter measures the grid current and when the oscillator circuit is coupled to a resonant circuit a reduction in grid current is obtained. This is called the grid dip. However, when it is used as a wavemeter and coupled to an rf source, an increase in current is obtained at resonance.

The GDO and impedance meter can be used to accomplish the following:

1. Determine the resonant frequency of tuned circuits, including antennas.
2. Determine the impedance of circuits, receiver inputs and antennas.
3. Determine the length of half-wavelength or quarter-wavelength transmission or tuning stub lines.
4. Determine the "Q" of a circuit or component with the aid of a VTVM.
5. Determine the resonant frequency of individual coils, capacitors or crystals that are within the range of the GDO.
6. Determine the rf frequency of energized circuits.
7. Monitor a radiated rf signal with the aid of headphones.
8. Neutralize rf stages.
9. Locate parasitic oscillations.
10. To align receivers and television sets.
11. Determine where BCI and TVI is entering the radio or television receivers.
12. Determine unknown inductance.
13. Determine unknown capacitance.

Now if you will step into the lab we will try to demonstrate how these instruments can be put through their paces. Let's begin with the simple functions and then gradually creep up to those which are more complex so they don't scare us before we get started.

An oscillator-detector

Simply plug in a pair of headphones (if GDO has facilities for them) and "zero-beat" with the radiating signal. This then will be the frequency of the radiating signal.

Crystal frequencies

Connect a one turn loop of wire across the crystal and couple the GDO close enough to get a dip of the meter when resonance is obtained. It is always wise to check lower frequencies to be sure it is the fundamental frequency that is being indicated.

Frequency determination

Generally the GDO has a switch which is used to remove the plate voltage from the tube. The tube will then serve the function of a diode and the meter as a diode load.

When a peak deflection of the meter is obtained, this will indicate the frequency of the radiating signal.

Resonance of an RF choke

When an rf choke is used as a parallel or shunt fed circuit, it must be free of self resonance over the operating frequency range of that circuit or it may burn up. The popular pi tank circuit is an example. Place a short circuit across the choke and then determine its self resonant frequency by coupling the GDO close enough to indicate a dip on the meter when the resonant frequency is obtained.

Neutralization

Apply plate power to the exciter stages and filament power only to the stage being neutralized. Use GDO as a wavemeter and couple close to the tank coil in the stage being neutralized. Vary the frequency of the GDO until maximum reading is obtained and then adjust the neutralization for minimum GDO meter reading. The circuit being neutralized may have to be retmed and the above procedure repeated with a closer coupling of the GDO to the Tank coil.

IF alignment

Tune the GDO to the desired frequency and couple it close to the if coil to be aligned. Adjust the if coil until a dip is observed on the meter. The if coil will then be tuned to the desired frequency.

Inductance and capacitance checking

To determine the value of an unknown capacitor, connect it across a known inductance and use the GDO to find the resonant frequency of the circuit. With these known values a reactance chart will give the value of the capacitor. Some GDO's supply a chart which corresponds to the coils supplied with the GDO as the known inductances. To determine the value of an unknown inductance, connect a known capacitance across the coil and use the GDO to find the resonant frequency. Again, the reactance chart may be used or the following formula (which may be used for either inductance or capacitance) for resonant circuits:

$$L = \frac{1}{39.48\ (f^2)\ C} \quad \text{or} \quad C = \frac{1}{39.48\ (f^2)\ L}$$

Where f = cycles per second
L = inductance in henries
C = capacitance in farads

The inductance of an air core coil can be estimated by the following formula:

$$L = \frac{(rN)^2}{9r \neq 10w}$$

Where L = inductance in microhenries
N = number of turns
r = radius of coil in inches
w = length of coil in inches

Q measurements

Connect a condenser across the coil so the tank circuit resonates at the desired frequency. Connect a VTVM across the tuned circuit and tune the GDO until maximum reading is obtained on the VTVM. The GDO coupling may be changed until a convenient value is obtained on the VTVM and then it must not be moved during the remainder of the test. Note the resonant frequency f_c then detune the GDO to a lower frequency until the VTVM reads 70.7 percent of its original or peak value and call this frequency f_1. Now detune the GDO to a higher frequency until the VTVM again reads 70.7 percent of its original or peak value and call this frequency f_2. The Q is then calculated by using the following formula:

$$Q = \frac{f_c}{f_3}$$

Where f_c = is the center of resonant frequency
f_3 = the difference between f_1 and f_2

Parasitic oscillations

By using a pair of headphones with the GDO, the parasitic oscillation frequency may be determined. Turn the power off of the stage being checked and then use GDO to find the circuit which resonates at the parasitic frequency by moving the GDO slowly around the wiring. When a "dip" is observed, moisten the finger and touch an ungrounded point of the circuit. If a change in the dip is observed, it indicates that it is the portion of the circuit that would be a likely suspect.

BCI and TVI locator

Most of the BCI and TVI problems can only be resolved at the receiver, either by installation of filters, resistors or condensers or a combination of all three. The problem is—where is the rf entering the receiver? Use the GDO tuned to the frequency which produces the greatest amount of interference. Probe

around with the GDO until the most sensitive spot is located, which is indicated by watching or listening to the receiver interference. After the point of entry is determined then the appropriate corrective action can be accomplished.

Antenna measurements

Space does not permit to discuss all types of antennas and adjustments so only a few will be mentioned to give some idea on the use of the instruments. At this point it should be mentioned that inductive type coupling should be used between the GDO and antenna when checking near the current maximum point and capacitive coupling when checking near the voltage-maximum point.

The beam antenna has gained tremendous popularity in recent years plus many headaches for those striving to obtain the maximum effectiveness. Most of the headaches can virtually be eliminated by using the GDO and Impedance meter (Z-meter). Let's take a look at a 3 element yagi and see what has to be done to obtain a good adjustment. The element lengths must be physically adjusted or electrically loaded to obtain resonance at the desired frequencies and the feed point impedance must match the impedance of the transmission line. These two points are not the only considerations for beam adjustment but they are the most important factors. The GDO can be inductively coupled to each element and the elements adjusted until each one is resonant at the desired frequencies. It is best to make the measurements while the antenna is in operating position. This is very difficult to do in many cases but let's assume you can. After the elements have been adjusted, the feed point must be adjusted to match the line. The Z-meter and GDO will be used to accomplish this adjustment. The Z-meter is basically a resistance type bridge with a calibrated potentiometer as one of the bridge arms. Connect the Z-meter directly to the antenna feed point. Couple the GDO to the Z-meter inductively thru a couple loops of wire connected to the other terminals of the Z-meter. Tune the GDO to the resonant frequency of the beam and adjust the Z-meter to the dip or null. If the impedance indicated by the Z-meter is not the same as the transmission line then readjust the matching network and redip the Z-meter until the impedances are equal.

Now—if you can't adjust the antenna in the operational position you still can determine the resonant frequency and the impedance by standing on the good old Terra-Firma. The procedure is a little more involved but effective. First—we must have a means of electrically connecting the instruments to the antenna. This is best accomplished by a transmission line a half-wave or a multiple of a half-wave in length. Determine the height of the antenna above ground and calculate how many half-wave lengths of line will be required by using the following formula for a half-wave length of line:

$$L = \frac{(492)\ (K)}{f}$$

Where L = feet
f = megacycles
K = propagation constant (RG/8 is .66)

This is an approximate length so be sure and cut it extra long because now we will find the exact physical length. Why an exact physical length? A halfwave length of transmission line will reflect the resistance placed across the output at the input end of the line, i.e. if a 50 ohm non-reactive resistor is placed across one end of a half wave or multiple length thereof, the GDO and Z-meter will indicate 50 ohms at the other end of the line. Cut the line somewhat longer than calculated above, short one end and connect the Z-meter to the other end of the line. NOTE: Keep twin lead off the ground and away from metal objects. Set the Z-meter to zero impedance and couple the GDO inductively to the Z-meter. Adjust GDO frequency until the fundamental frequency causes the Z-meter to dip or indicate a null. The frequency indicated should be lower than the desired frequency. Simply cut a few inches of cable off, short the end again and readjust the GDO. Repeat this procedure until the desired frequency (which should be the same as the resonant frequency of the antenna) is obtained. You will then have an electrically halfwave length of line or a multiple thereof.

Coax or twin-lead may be used for the half-wave length line when checking the impedance of the antenna. Connect the line to the antenna, hoist the antenna up to its operating position and adjust both the Z-meter and GDO for the null indication. If the antenna is not resonant at the desired frequency, the driven element should be readjusted a measured amount and then note the frequency change. This will give you an idea how much the resonant frequency changes with a corresponding element change. Now adjust the matching network to the desired impedance. This will be accomplished when the Z-meter dips at the desired impedance with the GDO

set at the resonant frequency of the Antenna.

What would you do if your 100 foot coax cable developed a short someplace along the line? Replacing the whole line would be too expensive. Simply connect the Z-meter to one end of the line, adjust the Z-meter for zero impedance and then adjust the GDO for lowest frequency which will produce a null on the Z-meter. Use this frequency in the formula given for a halfwave length line and carefully calculate the length which will be the distance from the input end to the short.

A quarter wave length tuning stub can also be determined by using the procedures just outlined for the halfwave length line except a quarter wave line reflects a short at the input when the output end is electrically open. Now that we have mentioned the quarter wave length line, some may be wondering just what useful purpose does it serve. The quarter wave tuning stub (as it is sometimes called) may be used for antenna matching, TVI elimination or matching two units which have different impedances. The quarter wave matching stub can be used as a matching device on antennas which is explained in most antenna handbooks. It may also be used to eliminate an interfering frequency from entering the TV. This is accomplished by connecting a quarter wave stub to the TV antenna terminals which is a quarter wave in length at the interfering frequency.

Another use for the quarter wavelength matching stub is to permit maximum signal transfer between the source and a load which have different impedances. If the signal source impedance was 100 ohms and the load impedance was 52 ohms, a 72 ohm quarter wavelength of line would give a good impedance match. Hold it just a minute, how in the world did we come up with that 72 ohm business? Simple—another formula will give us this information.

$$Z_0 = \sqrt{Z_s Z_a}$$

where Z_0 = Impedance of quarterwave matching stub

Z_s = Impedance of the source

Z_a = Impedance of the load

Very little has been said concerning the various methods of GDO coupling. Actually—only two types of coupling are used; inductive and capacitive. Capacitive type coupling may be used on shielded coax cable, the ends of antenna elements and generally where the voltage maximum exists. To obtain the greatest accuracy, the GDO should be loosely coupled. Parallel coupling to inductors can be used to obtain maximum coupling.

. . . WØBMW

Charles Landahl W5SOT
121 Barranca Road
Los Alamos, New Mexico

The Care of Storage Batteries

Lead-acid storage batteries will deteriorate rapidly unless given proper care. When it is remembered that millions of people in automobiles call upon the "box full of pickled amperes" to start them rolling each day, it becomes easier to realize how much mechanized America depends upon the battery. It is a silent servant that is often taken for granted until a car won't start, a mobile radio system fails to respond to the press of a button, or a hole appears in your clothing due to a splash of electrolyte.

Many standard quality batteries can be made to perform at peak capacity for unusually long periods; sometimes as much as a year beyond their guarantee, provided some thought is given to their care and upkeep. In the fully charged lead-acid storage cell, the active material in the positive plate is usually lead peroxide, and in the negative plate is found pure sponge lead. All of the acid is in the electrolyte which is a dilute solution of sulphuric acid. A direct indication of full charge is that the specific gravity is at its maximum. A hydrometer reading will lie between 1.210 and 1.275, depending upon the type of service for which the battery was designed. For example:

1.210 Emergency lamps
1.245 Standby light duty service
1.260 Automobiles
1.275 Heavy duty such as electric fork lifts

As a battery discharges, both the positive and negative plates are gradually converted to lead sulphate. The charging process re-converts the plate material back to the lead and lead peroxide, and returns the acid to the electrolyte. The charging process usually produces a "gassing effect" in the cells. As full charge is approached, the cells cannot absorb all of the electrical energy and the excess energy acts to break up the water of the electrolyte into hydrogen and oxygen. This then is the primary reason for the need to add water to batteries which are in service. As a matter of interest, you may have noticed on automobiles having ammeters, that the "voltage regulator" tends to automatically take care of reducing the charge as the battery builds up after a particularly hard start, or, if some other drain has occurred while the generator was not operating.

In order to extend the life of your battery you should keep the outside of the case clean. If electrolyte or water has spilled onto the top, wiping with a cloth is not adequate. Use a solution of common baking soda and water (4 tablespoons to a quart) to flush the top of the case. A foaming action will be noted as the soda neutralizes the acid. When the foaming stops, wash the residue off the surface with clean fresh water and allow the top to dry. *Be extra careful not to get the soda solution inside the cells.* A convincing experiment which demonstrates the need for a clean dry battery top can be made with a volt-ohmmeter. Using the volts scale in the lower range, say 10 or 12 volts, put one lead on a terminal of the battery and probe with the other test lead in the mastic of the top. If the surface is damp and dirty, a reading of several volts will be noted. A moment of reflection will lead you to the realization that here is a "thief at work." A small electrical discharge path through the surface dirt is continuously draining the charge out of the battery.

Water should be added to the cells as they need it. Try to maintain the level of the electrolyte above the plates. Use distilled water whenever possible. The tap water in most cities and towns contain among other things iron and minerals. These impurities can act to harm the battery and shorten the life by creating internal losses. Distilled water can usually be bought at drug stores and hospitals and sometimes in super markets. A source of reasonably pure water is the "frost" on the cooling coils of refrigerators.

Batteries on standby or light duty service should be cycled when specific gravity drops to 1.180 and at 30 day intervals regardless of specific gravity readings.

Some of the meanings of the words used by technicians in the care of batteries are as follows:

Cycled, cycling, cycle charge: refers to complete discharge, followed by complete recharge . . . (start at 20 amps per 100 ampere-hours of capacity, continue until the electrolyte reaches 110°F, or is beginning to gas rapidly, then drop to finish rate.)

Equalizing, finishing: An extended finishing charge to insure driving off all sulphate from

plates and equalizing the specific gravity readings between cells, 4 to 8 amperes per 100 AH of battery capacity for several hours.
Initial charge: A forming charge of long, low rate; used when placing new batteries into service.
Trickle, constant current: A continuous long low rate used to keep a battery in charged condition. (example: 100 milliamps/100 AH)
Emergency, hot shot: Used to put maximum energy into a battery in the shortest time *without seriously damaging* the battery. The emergency charge should be avoided unless close supervision is made of the charge so as to avoid excessive gassing, or, temperatures above 110°F. Another danger flag during an emergency charge is a cell voltage greater than 2.4 volts while the charging current is above the "normal or finish rates." During a charge, gassing occurs when the cell voltage reaches 2.3 volts per cell and will increase as the charging progresses. When a point is reached where most of the energy goes into gas, the amount of hydrogen released is about one cubic foot per cell for each 60 ampere hours input. A 4% concentration of hydrogen in the air can be an explosive hazard. Avoid the emergency charge.
Temperature: The preferred operating temperature is about 70°F. Temperatures of 125°F and more can cause early failure of the cells. Low temperatures reduce the capacity of a battery to deliver current. Winter becomes one of the times that batteries require careful attention. For example, it is known that the electrolyte will freeze at the following temperatures and specific gravities:

Degrees F.	Approx. Spec. Gr.
+20	1.100
+10	1.150
0	1.185
−10	1.120
−20	1.235
−40	1.265

Dry-charged batteries: These are usually manufactured with the intention of storage for a period before use—say up to two years. The process consists of charging and drying the plates in a carefully controlled atmosphere free of air or oxygen. When placing these batteries in service, they should be filled with an electrolyte about 10 points weaker than the rated full charge specific gravity marked on the case. These batteries should receive an equalizing charge before use.

In conclusion, lead-acid batteries do not require routine overhaul or solution changes during their life except as a result of accidental damage or spill. . . . W5SOT

OSCAR IV Is Up!

December 21, 1965

Dear Editor:

As I write this information, time being 12:30, the Titan 3C was a success. The Oscar 4 should be in the proper orbit and ejected now. The amateur satellite should have been turned on by 12.08 PST time. It is expected that it will be ejected over Equador.

The frequencies listed in the Sentinel were the ones that we were going to use, but Bill Orr (Oscar headquarters) changed them to input: 144.1mc—output center freq.: 431.972 —/+ 10kc—beacon freq.: 437.962mc.

The TRW Systems Radio Club back in August, also known as the STLEA Radio Club, was approached by John Chambers, Jim Ewing, Skip Freely, W. R. Hillard, and others, with the blessings of Bill Orr, as to the possibilities of the Club becoming engaged in the Oscar project. We were asked to be a back-up for Bill Orr in case they could not make their payload on time for the equatorial orbit launch. We talked it over and came to the conclusion that since we have a lot of good junk around and the experience of past satellite communication systems under our belts, the President, Mac McGrew, W6YCZ, said "why not". Mac left the Company for his own Business a little later and William McClellan, W6BJU became president. He also works in the r.f. and communication lab. Hector Nadal, K6RVO, Sec'y. and Andy Dolak, W6VHF, Treas.

The transmitter was built by Al Jensen, WV6DOW, of Pacific Semiconductors, a branch of TRW Systems. Output of the transmitter is approximately 2.7 watts. The solar cells are capable of producing 15 watts of power. The output of the transmitter had to be sacrificed to keep it linear for sideband operation. The transmitter has the capability of 6.5 watts, but had to be compatible with four modes: SSB, FM, AM and CW. The checkout of the transmitter was done by Herb Gleed, K6ZPX. The receiver is of comparable design to any other major satellite, as the boys here at TRW Systems have built them before. Ray Eastwood, K6MWR revamped 138 mc receiver to a 144.1 mc receiver with a passband of 11 kc. The xtals used aboard Oscar 4 are those made by International Crystal Co. Jim Ewing, K8RJM/6, was a great help with the entire project. He and Al Lee, W6KQI, and others helped with the beacon logic and the remote control. The remote control is a NASA and FCC requirement. The beacon timer interval is 8 minutes, which is subject to change with temperature encountered. The 431 mc antenna was designed by L. A. Cholewski, K6CRT, and is a co-axial dipole. The mounting heighth of the antenna was selected for the best radiation pattern. The three 2 meter antennas are all hooked up in phase. There is concern among many of the boys as to the faraday field polarization in space which will be a slow change and a loss of about 3db of signal strength. Skip Freely, K6HMS, who did pioneering with past Oscars, is putting some gears and other mechanism to his 8 ft. dish to compensate for the faraday field. John Chambers, W6NCZ, also a pioneer with past Oscars, has elevation and a 16 ft. dish with a probable 24 db gain. He has made up the 3db loss with gain. There was a thin metal foil scroll made by Andy Dolak, W6VHF, on his teletype machine, and it has the names of all the participants, giving them the honor of having their names travelling in space.

The Oscar 4 has the boys stamping out chassis for 432 mc converters. Many are getting their feet wet in the higher frequencies. There is much thought being given to the high frequency antennas as well.

Archie Landry, K6MSQ, "mechanical genius", gave the first shot in the arm to the project. He made everything look so simple. Jim Williams, W6RTG, worked out problems encountered in some of the stages of the game. D. E. Moore, not a ham yet, flew to Denver, Colo. to check the mounting holes in the frame that housed all four satellites. He was impressed by RCA's sliding rack which their satellite was mounted on. He also flew to Florida to mount the solar panels and set the spring type ejection system. The pin which holds the spring is sheared off by a squib upon command. The spring not only tosses the payload out, but starts it spinning like a top. Roger Trap, K6SSN, was on the antenna project. Harry Gold, WB6AWB, who works with solar cells, did a great job on the solar panels. He at first encountered road blocks. No one would give him data on the cells we were to use. This is where W. R. Hillard, K6OPZ, came into play. He is the boy who greased the skids a little. He would go right to top management, then a little while later people came carrying the specifications to Harry Gold. There are many hams at TRW, both management and employees. Dr. Ruber Mettler, Dr. Thiel and others gave their blessings to the project, as well as the Air Force. John Chambers gave technical direction and handled the political end. Ron Pitcher, not a ham, worked the hardest on the project.

There were a few problems along the way: xtal changes, trouble with logic, getting three similar banks of solar panels. We had a little trouble getting the shaker to get to 14 G's random vibration for about 30 seconds. This vibration test was witnessed by a representative from Martin Aircraft. He had to be sure that our tetrahedral-shaped satellite would not fly apart and injure their satellite which was adjacent to ours. The shipping crate which was 1½ in. too big for the plane it was scheduled for for flight created a hunt for a plane with a bigger door. We were told about a month and ½ ago that we were "it", #1. Bill Orr couldn't make it. Oh well, we made it . . . only to hear that they knocked us into a lop-sided orbit.

Andy Dolak W6VHF

Power Tubes

This is only for oldtimers. You youngsters who got your ticket in the last ten years know all about this, so just quit reading now and go on to something more exciting.

I have said many times that when you get a new Handbook, don't throw the old one away. There is information in the old books which is not in the new ones—and really good stuff, too. For one thing there is no diagram of a superregenerative receiver. It's mentioned, but no construction articles.

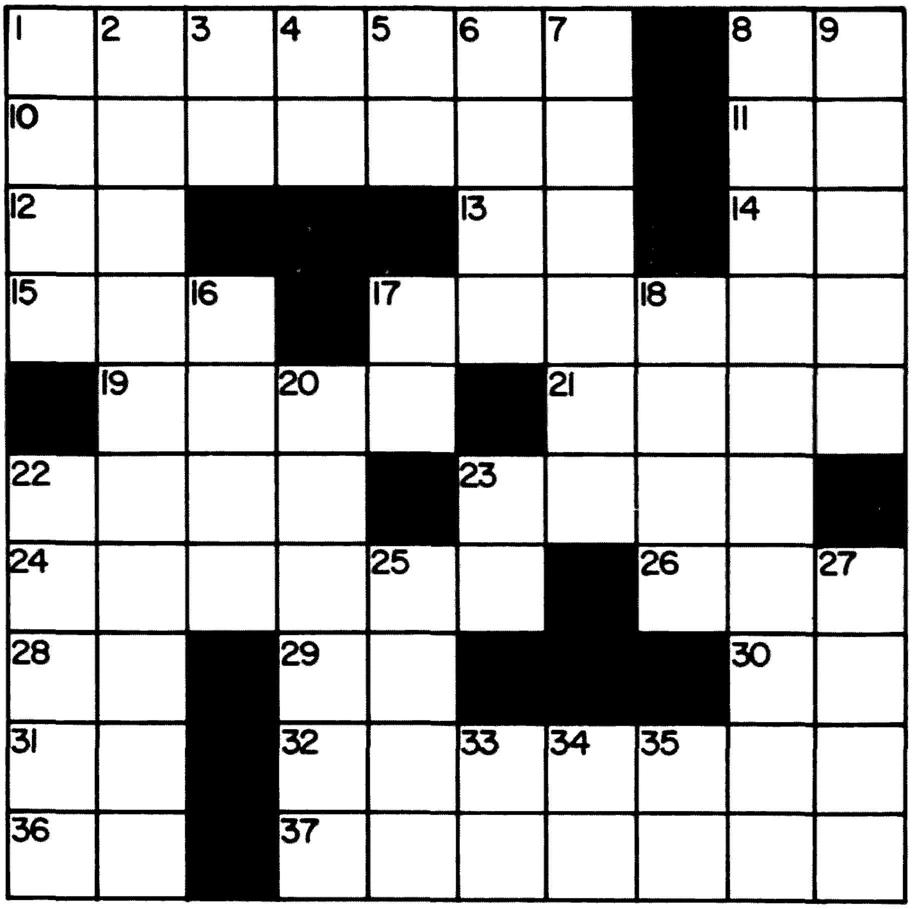
Anyhow, about power tubes. Before WW 2, a Taylor T20 was a real good tube that would handle about 75 watts with 700 volts on the plate. RCA-809 would take 100 watts but needed 1000 volts. Now these were transmitting tubes especially made for transmitters and cost a fair price of change, about $5.00 20 years ago. They were quite large, too; about the size of an 866. A 100 watt transmitter took up three units the size of a DX-100 and if you had a rack to put all this stuff in, then you really had something to make you proud.

Today, look at the size of a 200 watt transmitter, then take a look at the plate voltage. The tubes are nothing but receiving type tubes as shown in the RCA tube manual. This is where the new Handbook lets us down. The old books told what and how to run a receiving tube in a transmitter . . . but not so any more.

A few examples of good receiving type tubes that thanks to TV (the beast) gives good tubes at half the price of the big tube cost 20 years ago should include 6DQ6, 90 watts for $2.08, and the 6DQ5, a whopping 315 watts if you air cool and for only $4.20. If you want small size, look at a 6CZ5, smaller than your thumb, which loafs along at 20 watts with only 350 plate volts for $2.05. If you want a compact but potent rig, take a look at some of the dual purpose tubes like the 6CX8. Here are all the makings for a crystal oscillator and final for 160 through 6 at 12 watts for $1.83.

What fun we could have had with tubes like this just running them at their rated value and not like we did a pair of the old 45's with slotted bases and 800 volts on the plates to get about 10 watts in the air on a bread board 30″ long × 12″ wide, and the power supply on the floor.

. . . W8QUR



Joseph Gaudet
61 Adele Avenue
Haverhill, Mass.

Crossword

Across

1. Ham
8. Algeria
10. The Ticket
11. Beam material
12. Volume level (ab.)
13. Spain
14. Ha, ha
15. Automatic load control
17. *To make certain*
19. Sorts
21. The band is ——
22. Rag chew
23. Soon
24. What you should do in a net
26. New Ham Shire
28. Belgium
29. Calcium
30. **Eire**
31. This —— that
32. Citadel in UA1
36. Between Canal Zone and Marshall Islands
37. Known only to a few

Down

1. Inventor of electric bulb
2. Unit of inductance
3. Type of current
4. Chemical element
5. Printers' measure
6. Put into action
7. Motive
8. Temperature scale
9. Strange
16. Fasten
17. Wait!
18. On top of
20. Raps
22. The guy who stole my rig
23. Nearby
25. Nearby
27. Evils
33. ARRL appointee
34. OM
35. airebil

Solution on p. 114.

A	M	A	T	E	U	R		F	A
L	I	C	E	N	S	E		A	L
V	L				E	A		H	I
A	L	C		A	S	S	U	R	E
	I	L	K	S		O	P	E	N
C	H	I	N		A	N	O	N	
R	E	P	O	R	T		N	H	S
O	N		C	A				E	I
O	R		K	R	E	M	L	I	N
K	Y		S	E	C	R	E	T	S

advised by my lawyers that
don't you ever proofread y
are a bunch of crooks and
this is the last straw for
have no other recourse but
should be tarred and feath

Letters

Dear Sir:

In response to the article in the November issue of *73* "Lovers Lane" by Marianne Lattak, I must say that it drew many similarities with a few escapades in hamming here at WAØJHH. When my lovely YL saw the article, she sweetly told me, "I told you so". Since then I've learned to keep the rig at home when I date.

Tom Holland WAØJHH
Minneapolis, Minnesota

Hi Wayne:

Re *QST* for August, p. 64, Bill Orr's letter, "The Multiple Untruth." You have a printing press—would you please challenge Bill to stop speaking darkly of "masters in the art of fantasy" and rumbling like an old volcano. If he is upset, let him name names, name inaccuracies, and with documentation correct them. You know, considering his recent cold objectivity, I think he means you and K6BX, hi!

And while you have it open, reread the editorial on p. 9. At first I thought John Troster wrote it, but for fun, try to picture Arthur Godfrey as he might read it aloud with his inimitable inflections.

Marty Barrack WA2ZKR

Dear Wayne,

This business about our working only certain DXers or deliberately avoiding or delaying DXers from any of our spots is absurd. Chuck and I work absolutely everybody we hear in the order we hear them, with one exception. We've recently gotten pretty fed up with the rude operating tactics and poor sportsmanship of a number of DXers and, by way of a hint, we may delay working them until they behave. Unfortunately some of the fellows high up on the honor roll are the worst offenders. For the record we have now hit twelve spots. Four of them never having been active before (8F Indonesia, 1S9 Spratly Island, HC8E Ebon Atoll, and T19C Cormiran Reef), another four quite rare (BY Communist China, ZM7 Tokeleaus, HS Thailand, and XZ Burma), and have had about 60,000 contacts during the last three months doing this. The only favoritism shown contributors is to mail direct cards to the 300 or so DXers who are making this possible.

Don Miller
Fiji Islands

Dear Wayne,

A note about the article on Pi-Networks by W8QUR. He states that the big disadvantage to the pi-nets is low efficiency. I would like to say that the low efficiency is not due to the pi-net, but to the all-band feature usually built into the network. I have been a commercial broadcast engineer for several years and have built and designed commercial broadcast stations. I have yet to see a pi-net or for that matter, a t-net, that will not give at least 75% efficiency. Where I work, we run 5,000 volts at 1.2 amps to the final amplifier. Giving us 6,000 watts of input. Of this we get 5,000 watts measured at the antenna common point. This is over 80% efficiency. Not bad for a pi-net I'd say. Of course the final is class C, but even a Class C amplifier can't give anymore efficiency than the coupling network will allow. Trouble with low efficiency pi-networks is the result of "low-efficiency" design, not the nature of the network.

I certainly enjoy the fine work you're doing Wayne, in bringing good articles to the ham public. It's about time someone got the scoop over QST. Thanks again.

Jan Chadwell K7JBS
Ogden, Utah

Dear Wayne,

I've been reading A.G.W. Cameron's book on Interstellar Communication. Very interesting. They have such complete proof that interstellar travel is impossible and that radio communication is the Only Answer.

It just happens that I have also recently read a book translating a scientific work about 500 years ago. I'll quote a passage from it:

To travel instantly from one place to another:
The genie *Ampharoil* presides over instant travel to all places, and he is the genie who was called by King Solomon the King of the Genies of Flying. And he comes to you when you know his name, and it's thus—

A M PH A
R O L A
MPH A R
O L A M

And this is the way in which it is done. Five days after the full Moon, five things are to be taken, and they are five stones, each from a place where no sun is to be seen. Then the magician, taking his hat and his shoes in his hands, goes to a place where there are high winds, and he calls in a loud voice, so that the genie may hear him. And he calls upon him in these names, *"Ampha, Rola, Mphar, Olam!"* as it is written in the square.

I can't help having a strong feeling that a lot of what we're writing now will look somewhat similar 500 years hence.

So radio communication is the *only* possible means of communication?

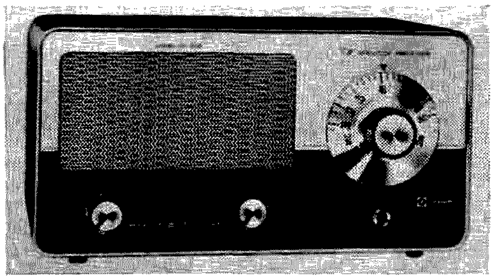
Hah! and a magically summoned genie is the *only* way to cross the Atlantic in a single day, too. It is, if you don't know any useful amount of physical science. And if you know a little physical science, you can "prove" conclusively that interstellar travel is impossible, that UFO's can't exist, and that radio is the *only* possible communication method.

Wonder what the speed of thought is?

Maybe telepathy doesn't depend on electromagnetic phenomena, and isn't, therefore, subject to relativistic limitations.

John W. Campbell W2ZGU
Editor
Analog Magazine

NEW PRODUCTS



Knight-Kit VHF FM Receivers

The new Knight-Kit VHF FM receivers are an ideal, inexpensive way to monitor communications services for emergencies, business or just plain snooping. One covers 30-50 mc and the other 152-174 mc. They come with prewired and aligned front end and are very easy to build, as are all Knight-Kits. Squelch is provided with a front panel adjustment so you won't have to listen to all sorts of ignition noise, hiss and other racket. Price is a low $39.95 and you can get more information from Allied Radio, 100 W. Western Ave., Chicago, Illinois 60680.

Broadband Receiver Protectors

Why buy protection? Radiation Devices Company claims in their brochure RP-1,2 that you need it to prevent transmitter leakage through inadequate antenna transfer relays from damaging costly transistors, mixer diodes, and other solid state units in your receiver front end. Two models are offered: the RP-1 covering from 3 to 54 megacycles with better than 70 db isolation and the RP-2 for low noise VHF-UHF use with better than 40 db isolation from 50 to 450 megacycles. The RP-1 also may serve as a T/R switch with transmitters of less than 25 watts output. Neither model requires tuning or will generate harmonics which cause TVI. Power for operation may be derived from your transimtter or receiver. Choice of type N, BHC, UHF or RF Phono connectors. RP-1, $10.95; RP-2, $12.95 postpaid. Box 8450, Baltimore, Maryland 21234.

Amperex Varactor Theory and Applications

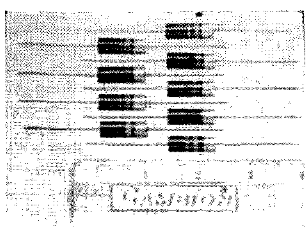
A new Amperex application booklet covers theory of veractor multipliers, practical multipliers, filters and a working tripler using the 8458 twin tetrode and a 1N4885 varactor (very similar to W9SEK's article in March 73) to get 22 watts on 450 mc at lost cost. Copies of the report S-124, S-125 can be obtained by writing on company letterhead to Amperex, Hicksville, N.Y. 11802.

Servicing with Dip Meters

A useful new Sams book is *Servicing with Dip Meters* by John Lenk. All hams know how valuable dip meters are, and this book tells you how to use them for the many measurements they can make: resonance frequencies, capacitance, inductance, antenna matching, crystal and filters, impedance, Q, wavelength, field strength, SWR, etc. The book, catalog number DML-1, is available at your distributor for $2.95, or from Howard Sams, 4300 W. 62nd St., Indianapolis, Indiana 46206.

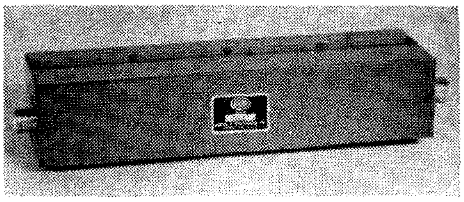
Harvey Radio Catalog

Harvey Radio's fat (over 500 pages) new 1966 catalog is now available. It covers about all the industrial, amateur, consumer and professional parts. You can get a copy from Harvey at 60 Crossways Park West, Woodbury, N.Y. 11797.



Cambion Chokes

Cambridge Thermionic (Cambion) has announced a series of new shielded chokes that provide high impedance in an extremely small package. They're only about .4 inches long and .2 inches in diameter, but come in values from .1 μh to 100 mh. For more information, contact W. G. Nowlin, General Sales Manager, Cambridge Thermionic Corp., 445 Concord Avenue, Cambridge, Mass.



New B and W TVI Filter

The new B and W model 427 rf filter will virtually eliminate extraneous TVI-causing frequencies from transmitters operating in the 25-50 mc range. It can handle 1000 watts at 50-75 ohms, and comes with UHF connectors. Price is $19.86, shipping prepaid. Barker and Williamson, Inc., Bristol, Pa.

ABC's of Microwaves

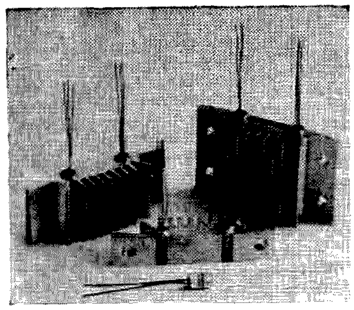
As our use of the spectrum extends higher in frequency, it becomes increasingly important for hams to know as much as possible about UHF and microwaves. A simple way to do that is with the new *ABC's of Microwaves* by Charles Woodruff. This easily understood book makes extensive use of the pictorial techniques and clear language that has marked the other books in Sams' ABC series. AMW-1 has 144 pages and costs $1.95. It's available from your local wholesaler or from Sams, 4300 W. 62nd St., Indianapolis, Indiana 46206.

Inventor's Idea Book

Want to invent something that can make you rich? The new *Inventor's Idea Book* by George Lawrence explains the challenge of new inventions, stimulates your creativity and outlines 175 specific suggestions for needed inventions. It's 128 pages and the price is $1.95 from the publisher, Howard W. Sams and Co., Inc., 4300 W. 62nd Street, Indianapolis, Indiana or from the better distributors.

Two-Way Mobile Radio Maintenance

This practical field servicing book by Jack Darr is an up-to-date guide covering modern mobile servicing, planning, installation and maintenance. The author writes from practical experience and the book is well illustrated with on-the-job photos. *Two-Way Mobile Radio Maintenance*, TWD-2, 256 pages, $4.95 from Sams, the publisher or your local electronic distributor.



Amperex Heat Sinks

Here's another clever idea from Amperex. It's a heat sink for manufacturers of solid state phonographs, etc. The interesting thing is that the sink is slightly bowed so that it's easy to insert TO-1 transistors in it, but tightening the sink to a chassis straightens it out and clamps the transistors very firmly for excellent heat dissipation and low thermal resistance. It could save a lot of time for manufacturers since there aren't any separate pieces to put together, align, etc. More information from Amperex Semiconductors, Slatersville, R.I. 02876.

Silver Plated Wire and Tubing

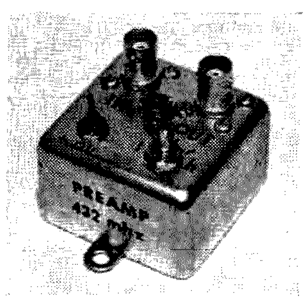
Radiation Devices Company offers silver plated wire and tubing of pure copper for use in critical tuned circuits of preamplifiers, converters, and transmitters. The plating is 0.5 mils thick in accordance with Federal Specification QQ-S-365A. Wire is available in #16, 14, and 12. Tubing is ⅛" outside diameter. Price of any size is 40¢ per foot. Minimum order $2.00 postpaid. Box 8450, Baltimore, Maryland 21234.

Wide Band Amplifier

Modular, solid state silicon, wide band amplifiers for preamplifier and general lab use in 50 ohm coax systems are available from Radiation Devices Company. Frequency response is within one decibel from 10 to 250 mc. Spot noise figure is 5db at 200 mcs. Gain over the one db bandwidth is guaranteed to be 10 db minimum. Modules may be cascaded for higher gains without instability. Maximum input voltage for linear operation is 500 millivolts peak-to-peak. Model WB-II is internally powered by two 9 volt transistor batteries and model WB-1E by an external power source. Connectors: N, BNC, UHF or RF Phono. Price: $20.50 each, either model, postpaid. Box 8450, Baltimore, Maryland 21234.

Precision Coaxial Terminations

Two series of precision coaxial terminations are offered by Radiation Devices Company. The LP-1 series are capable of dissipating one watt and are useful for terminating test pieces, noise generators, directional couplers, and may be used as standards in SWR bridges. VSWR of LP-1 series terminations is less than 1.05 from d-c to 1300 megacycles. Connectors: Type N male or female. Price: $12.00 each, postpaid. The MP-1 series are designed for medium power; up to 10 watts continuous in 50 ohm coax without heatsink and up to 25 watts with suitable heatsink. VSWR of MP-1 series terminations is less than 1.10 from d-c to 1300 megacycles. Connectors: Type N male or female. Price: $22.50 each, postpaid. Write for brochures LP-1 and MP-1 for more information. Box 8450, Baltimore, Maryland 21234.



432 mc Preamp

All of you on or planning to go on 420-450 mc will be interested in this inexpensive transistor preamp. It gives over 17 db gain and less than 5 db noise figure. Bandwidth is about 4 mc. It tunes the whole ham band and even up to UHF channel 34. Size is 2 x 2 x 2, power required is 12 v at 1.5 ma, and the preamp comes with BNC connectors. They'll even make them up for other frequencies. Price is a low $12.50. Tom O'Hara W6ORG, 10253 East Nadine, Temple City, California 91780.

ATV Research Catalog

Interested in ATV? Isn't everyone? You should get the ATV Research catalog. It contains many interesting goodies: complete kits of coils and other hard-to-find parts for TV cameras, lenses, mounts, vidicons, shields, printed circuit boards, etc. For a copy, write to ATV Research, P.O. Box 396, So. Sioux City, Nebraska.

(Continued from page 4)
big guns would be glad to spare a little time on intruder duty with a vigilante net providing some extra mark or space signals for commercial RTTY stations. These stations must have absolutely perfect copy you know, so it really wouldn't be difficult to make it profitable for them to find a better channel. Darned shame if Cuba, Haiti, etc., get pushed out of our bands . . . right?

If any amateur or club or net is interested in coordinating the Vigilantes I will cooperate to the fullest with 73. I suggest that those interested in helping out on such a project get together on 3815 kc at 0000Z and get things started.

ITU Report

The crushing defeat suffered by the U.S. at the Montreux, Switzerland, I.T.U. conference in November poses even more problems for the next conference . . . the one where ham radio stands to lose its shirt. What happened? Well, the French, Soviets, Africans and Asians got together and clobbered us. The U.S. came out of the conference with not one single proposal adopted and with not one American national on the executive roster of the governing body of the I.T.U.

The French have always been extremely uncooperative about amateur radio. Their regulations are, I believe, the most strict in the entire world and they certainly have one of the smallest ham populations of any modern country in the world . . . about one ham per 20,000 population as compared to one in 800 in the U.S. France made a determined effort to take away much of 10 meters in 1959. One wonders what France might be like today if the government had encouraged amateur radio, thus making it possible for them to have a large and growing electronics industry built, as it is elsewhere, on a foundation of amateur operators.

There is little amateur operation in the Asian and African countries and thus little reason for these countries to support amateur radio. We have an important story to tell these countries for amateur radio could be of great value to them . . . but I wonder if we will get that story told in time. The only organization in the world that is working on this problem is the Institute of Amateur Radio. Frankly, if every amateur doesn't jump immediately to support the Institute, I think we will have an awful time with our consciences along about 1970. I think the disaster can be prevented, but it is going to be a lot of work and be expensive. . . . Wayne

AREA news

Though few of you have probably ever heard of the Amateur Radio Editors Association, it is a "club" made up of the editors of ham club bulletins . . . or at least it is supposed to be. AREA was started by W8BAH back in 1961 with the idea of keeping editors informed on current amateur events. Unfortunately it evolved into a monthly bulletin devoted to biographies of those that paid their $7.50 to join the Association and not much else. All told some 200 people, most of them hams, paid to have their biographies published.

Things began to look up for the AREA when Bill Welsh WA6VTL, an Edison Award winner, was voted President. Bill got together with the Directors of the Association and drew up a new constitution which would put AREA back to sending out news. The new constitution was sent to the members for ratification. Well, W8BAH had to do something fast to hold onto his $7.50 biography business so he ignored the new and old constitutions and sent out word that he was holding an election immediately with DL4HU as the only candidate for president. I wrote DL4HU about this and got word from him that he knew absolutely nothing about it and that he was writing to BAH to tell him that he was not available.

BAH apparently sat down at his typewriter and held an election for AREA. I got an announcement from him that he had elected himself president, vice president, secretary and treasurer. Quite a landslide for him.

In the meanwhile the members turned in one of the largest votes in AREA history overwhelmingly accepting the new constitution. It looks as if the Association is going to continue on and grow healthily, but without W8BAH . . . one of the little dramas that are part of amateur radio.

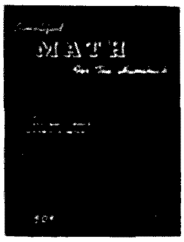
For information on joining AREA drop a line to Bill Welsh, 2300 W. Clark, Burbank, California 91506.

W2NSD/6

I'll be out in Los Angeles for the first week or so of February and would like to visit as many clubs as I can during this period. There are many fascinating things going on behind the scenes of amateur radio that I can't possibly write about in 73. In person I can spill the beans. Bill Welsh WA6VTL will set up my schedule of speaking so program chairmen should get in touch with him at 848-9340. Skeptics and official ARRL hecklers are most welcome. I am seldom dull.

73 Books

RECEIVERS. K5JKX.—If you want to build a receiver or to really understand your receiver, this is the book for you. It covers every aspect of receiving in author Kyles usual thorough manner. **$2.00**

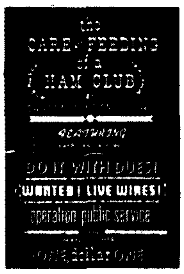


SIMPLIFIED MATH FOR THE HAMSHACK—K8LFI.—This is the simplest and easiest to fathom explanation of Ohm's Law, squares, roots, powers, frequency/meters, logs, slide rules, etc. If our schools ever got wind of this amazing method of understanding basic math our kids would have a lot less trouble. **50¢**

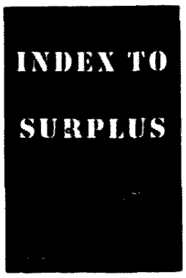
CW—W6SFM.—Anyone can learn the code. This book, by an expert, lays in a good foundation for later high speed CW ability. **50¢**

FREQUENCY MEASURING—WØHKF—Ever want to set yourself up to measure frequency right down to the gnat's eyebrow? An expert lets you in on all the secrets. Join Bob high up on the list of Frequency Measuring Test winners. **$1.00**

CARE AND FEEDING OF HAM CLUBS—K9AMD.—Carole did a thorough research job on over a hundred ham clubs to find out what aspects went to make them successful and what seemed to lead to their demise. This book tells all and will be invaluable to all club officers or anyone interested in forming a successful ham club. **$1.00**



ATV ANTHOLOGY. WØKYQ and WA4HWH.—A collection of the construction and technical articles from the ATV Experimenter. Includes a complete, easy to build vidicon camera and 50 other projects. The only book available about ham TV. **$3.00**



REVISED INDEX TO SURPLUS—W4WKM.—This is a complete list of every article ever published on the conversion of surplus equipment. Gives a brief rundown on the article and source. Complete to date. **$1.50**

TEST EQUIPMENT HANDBOOK. W6VAT.—Every ham needs to have and know how to use test equipment. This book tells you how to make valuable ham test gear easily and cheaply. It also covers the use of test equipment. **50¢**

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Caveat Emptor?

★ **Price—$2 per 25 words for non-commercial ads; $5 per 25 words for business ventures. No display ads or agency discount. Include your check with order.**

★ **Type copy. Phrase and punctuate exactly as you wish it to appear. No all-capital ads.**

★ **We will be the judge of suitability of ads. Our responsibility for errors extends only to printing a correct ad in a later issue.**

★ **For $1 extra we can maintain a reply box for you.**

★ **We cannot check into each advertiser, so Caveat Emptor . . .**

PICTORIAL STUDY in electrical theory and basic radio communication for the amateur. Understanding through visualization. Free details. Dwight Cross, 1212A Lynch Street, St. Louis, Mo. 63118.

TECHNICAL MANUALS. Signal Corp. Some of the available manuals R-390,A, SP-600, BC-610, I-177, TV-7, teletype manuals, test equipment. World's largest list 10¢. Quaker Electronics, Hunlock Creek, Pa.

QSLS BROWNIE-W3CJI, Highest quality since 1939. Samples 10¢, with cut catalog 25¢. 3111R Lehigh Street, Allentown, Pa. 18103.

POWERFUL NEW 572B's—2000 hour guarantee—never unboxed—$39.50 matched set of 4 postpaid. Need Drake DC-3 Len Malone, WA5DAJ Box 1222 Garland, Texas.

CHANGE CRYSTAL FREQUENCY—even plated type. Deluxe Kit includes ammonium bi-fluoride, holders, storage and etching vials, complete instructions. Only $2.00, Postpaid.—Ham-Kits, 16 West End Court, Long Branch, N.J.

COUPON BOOK—Special offers from various firms for members of electronic Experimenters' Club. Dues $2.00 or write for further particulars. Box 5332-EA, Inglewood, Calif., 90310.

TAPE RECORDING: Need someone with facilities to reproduce prepared 3¾ ips tapes in limited quantities. Good speech quality required. Original tape and supplies furnished. Write IoAR, Springdale, Utah 84767.

R U REALLY interested in Ham Radio? Send SASE for IoAR information and help fight Amateur Radio Apathy. W7ZC, Springdale, Utah 84767.

MOTOROLA T-19-23 low band AM base transmitter. 20 Watts to a 807. Metering, ac power supply, instruction book. Also Motorola T-69-20A mobile low band transmitter-receiver. 807 final. Best offers. Herb Whitney, Peterborough, N.H.

HALLCRAFTERS S-36 receiver, 27-143 mc. $50. 80 meter phone transmitter, 10 watt mobile with power supply and mike, $30. Phono Trix tape recorder, $10.00 CB transceiver, United Science Lab, works fine, $15.00. Heathkit signal tracer, $10.00. Paco grid dip meter converter to QRP transmitter, worked Detroit, $15.00. J. Strolin K1REC, 21 Ellen Street, Norwalk, Conn.

MUST SELL complete mobile rig! SB-33 transceivers, mount, mobile power supply, Shure model 401A mike, Newtronics MO-2 bumper mast with spring and four resonators. Used five months. $325 or best offer. Jim Crouse K4SET, Corry Field, Box 15368, Pensacola, Fla. 32511.

HEATHKIT APACHE, mike and PTT. Excellent condition, $110. Also Hy-Gain 2BDP, $5. You pick it up. WB2AUB. Call 516-767-8078.

HEATH SB200 $180, SB300 all accessories $270, SB400 $295, HDP21 mike $20, Superpro receiver $40, GEFM $35, Link $25, Eico VTVM $25. K9JCR, Box 94, Greencastle, Indiana.

ELDICO SSB100A transmitter bandswitching SSB/-AM/CW 100 watts built-in scope monitor, has really stable PTO. With manual and blower. Pick-up only. $170. Also Webster Bandspanner $7.50. Autronic Keyer complete $45. K2CUI. Phone 212-689-8957.

TRANSFERRING TO DENVER, Colorado April '66. Need QTH for XYL and myself. Reply airmail. TSgt Ernie Wachter K4UGL/DL4AM, Box 171 Det 100, 601st TCS, APO NY, NY 09670.

Why slave for that wallpaper?

Buy these certificates to dress up your shack. Be proud of the effort it took to earn the money to be able to afford them.

The CHC Certificate

The Certificate Haters Certificate is available to any ham with $1 who submits a signed statement that he has never been awarded any other certificates and that he will hate any that he happens to get in the future.

The WAAS Certificate

The Worked Almost All States Certificate is available to hams who have proof of contact with 49 states. It takes almost as much effort to work 49 as 50. Why should this work go unrewarded? Send the 49 QSL's in statabetical order or a statement signed by two responsible radio club officials that they've seen the 49, along with a note of the missing state. Mode stickers for CW, AM, SSB, RTTY, band stickers, and stickers for all contacts made within one year are available for $1 extra for each sticker.

The DXDC Certificate

Everyone knows that this matter of "countries" is ridiculous. The DX Decade Certificate requires contacts with ten countries (defined as members of the UN; too bad, Switzerland, Communist China, etc.). Same regulations and endorsements as the WAAS Certificate above. There are no stickers for more than ten countries.

Countries for DXDC. Members of UN.

Afghanistan	Greece	Norway
Albania	Guatemala	Pakistan
Algeria	Guinea	Panama
Argentina	Haiti	Paraguay
Australia	Honduras	Peru
Austria	Hungary	Philippines
Belgium	Iceland	Poland
Bolivia	India	Portugal
Brazil	Indonesia	Rumania
Bulgaria	Iran	Rwanda
Burma	Iraq	Saudi Arabia
Burundi	Iceland	Senegal
Byelorussian S.S.R.	Israel	Sierra Leone
Cambodia	Italy	Somalia
Cameroon	Ivory Coast	South Africa
Canada	Jamaica	Spain
Central African Rep.	Japan	Sudan
Ceylon	Jordan	Sweden
Chad	Kenya	Syria
Chile	Kuwait	Tanganyika and Zanzibar, United Republic of
China	Laos	
Colombia	Lebanon	
Congo (Brazzaville)	Liberia	Thailand
Congo (Leopoldville)	Libya	Togo
Costa Rica	Luxembourg	Trinidad and Tobago
Cuba	Malagasy Rep.	Tunisia
Cyprus	Malaysia	Turkey
Czechoslovakia	Mali	Uganda
Dahomey	Mauritania	Ukrainian S.S.R.
Denmark	Mexico	U.S.S.R.
Dominican Rep.	Mongolia	United Arab Republic
Ecuador	Morocco	United Kingdom
El Salvador	Nepal	United States
Ethiopia	Netherlands	Upper Volta
Finland	New Zealand	Uruguay
France	Nicaragua	Venezuela
Gabon	Niger	Yemen
Ghana	Nigeria	Yugoslavia

The RRCC Certificate

If you're a Real Rag Chewer, you can keep it going for at least six hours. This certificate is for hams who have had a single two station contact going for six hours with no interruptions. Include signed statement to that effect.

Each certificate application must include $1 to help cover the costs of administering the program, etc.

73 Magazine Peterborough, N.H. 03458

COLLINS 75A3, $250, Central Electronics MM-2, $60. Heath AJ-10, $35. WAP2, $12. W5M, $40. Jules Fantaski W8EYO, Rt. 1, Box 460, Stevensville, Michigan 49127.

COLLINS KWM-1, AC and DC power supplies, mobile mount, $400. Globe Highbander VHF-62, $60. Johnson 6N2 converter, $40. Cliff Alsop, 5927 Primrose, Indianapolis, Indiana.

3-6 MC ARC-5 receiver converter to the marine band, power supply, AC, complete $25. W6BLZ, 528 Colima Street, La Jolla, California.

EICO SIGNAL GENERATOR, model 320, 150 kc to 102 mc, $22. BC453 receiver, $14. BC459 transmitter, TVI'd, $12. Heath condensor tester CT-1, $7. Fitzgerald, Box 508, Moravia, New York.

RME VHF 602 transmitter, model number 65-440. Need schematic for this rig. Made by GC Electronics, they do not have one. Rush your price. Barney Sprayberry WA4UXW, 749 Oak Hill Drive, Trion, Ga.

CQ'S '57-'62 in binders, condition perfect. '63, no binder. Make offer. H. C. Snyder WØNVE, KHUB Radio, Fremont, Nebraska.

FREE LOVE is yours in fine equipment pampered by me—B and W 5100, NC-300, $350. Contact Ron WA2-JSF, 47 Ivy Street, Newark, N.J. Telephone 373-5375.

CLEGG ZEUS and 11 element 6 meter beam. Contact WB2CUD, 201-756-8340.

HEATH MARAUDER HX-10 and Warrior 1 kw linear amplifier HA-10. Both mint condition $375. R. Dingman WA1CUO, 4 South Elmer, Manchester, N.H.

TV CAMERA with control unit. Manufactured by Blonder-Tongue Laboratories. Observer model. Closed circuit. $395 or trade for Collins 75S-etc. or KWM2. Drake R4 $345. Drake T4X $345. TR4 $495. WA4LXX, 251 Collier Avenue, Nashville, Tenn. 37211.

CLOSED CIRCUIT television camera, video monitor, assorted TV lenses. Very reasonable. Ira Klein, 1439 52 St. Brooklyn. Phone 4-7083.

CLEGG VENUS with AC power supply. Apollo Linear $575. Will separate. Inquire. Heath HX-30 6 meter SSB exciter $175. Drake R4 receiver $275. Will ship or deliver within 100 miles. All inquiries answered and offers considered. Robert Klein WB2UKS, 96-09 67 Avenue, Forest Hills, N.Y. 11374.

SIX METER EQUIPMENT All excellent. Little Lulu transmitter AM, CW, 110, 12 volt. TVI proof, $100. Gonset converter broadcast band IF, 12 volt, $20. Clegg SSB speech booster, $50. homebrew linear using pair of 100TH's and power supply. Full kilowatt, no TVI, $150. WB2HOW, Joseph Ciardi, 106 Maple Street, Weehawken, N.J.

HETERODYNE FILTER 3000 cycle cutoff. Install in 500 ohm speaker line of any receiver. Unused high grade surplus Rated 25 watts. Two for $5. L-C Electronics, Box O, Freeland, Michigan 46823.

QSL SAMPLES? 25¢ (deductible) Russ Sakkers W8-DED, Box 218, Holland, Michigan.

FULL-SIZE beams; new; all 7/8" and 1" aluminum tubing; absolutely complete with boom and hardware; easily handles five KW; SWR 1:1; adjustable entire band; three-element 20-meter $22; two-element $16; three-element 15-meter $16; two-element $12; four-element 10-meter $18; four-element 6-meter $15; remit with order; express collect shipment; all orders honored. GOTHAM, 1805 Purdy, Dept. 73, Miami Beach, Fla.

PLATE TRANSFORMER 690v @ 450 ma. No C.T.117v pri. Sealed. Unused. $3.95 plus postage. Wt. 19 lb. Companion choke 1.2 h @ 450 ma. 1500 w.v. test. Unused. Sealed. $1.00 plus postage. Wt. 6 lb. A.R.C. Sales. P.O. Box 12, Worthington, Ohio.

CHRISTIAN Ham Fellowship being organized for Christian hams for fellowship, missionary efforts and tract ministry among hams. Christian Ham Callbook $1 donation. Write for free details from Christian Ham Fellowship, Box 218, Holland, Michigan 49424.

A RADIATING COAX is like a leaky hose. Less force at the nozzle. Broadband Toroid Balun Kit: 2" core, wire and full instructions. Handles kilowatt. Makes into 4:1 or 1:1 balun or use to make auto-transformer for matching coax to vertical at home or mobile. $5.00 plus 25¢ postage. Ami-Tron Associates 12033 Otsego Street, North Hollywood. Calif. 91607

HEATH TUNNEL DIPPER in mint condition for $20.00. Better hurry!!—W5LVQ 608 E. Warner, Guthrie, Oklahoma.

SELLING OUT: Drake 2B/xtal calibrator; Knight T-50, 50 watt cw transmitter; Hy-Gain 14AVQ vertical/roof mounting kit/80 meter loading coil. All in good condition. $265; package deal only. Free Knight V-44 VFO with deal. Clif Power, K1FEB, 34 Independence Avenue, Stoughton, Mass. 66222

OLD TIMERS HELP: Can anyone explain inscrutable fm-modulator circuit of McMurdo-Silver 906 signal generator? For sale: Reiner square-wave generator, $25.00. T. R. Jackson, Corinth, Vermont.

VIKING CHALLENGER matching VFO, three novice xtals, $85. Good condx. 48 states, 56 countries. K1FHR, Kleinfeld, Evergreen Dr., Woodbridge, Conn. 203-393-1825.

COMPLETE MOBILE or fixed station Elmac AF-68, PMR-8, Power Supply $150. Also a hi-power 600 watt AM 1 KW C.W. vacuum Variable final with Adventurer exciter, 3000 volt power supply $150. K5YTQ 4906 Justin Drive N.W. Paradise Hills, New Mexico.

6 F.M. MOTOROLA coffin-box transmitter and receiver. 12vdc. Tuned up 52.525, cables, crystals, speaker, etc. Beautiful condition. $80. FEDERAL ELECTRONIC SIREN—P.A., 4 lbs., all transistorized—latest model. 100 watts w/1 speaker, 150 w/2 output. Cost over $200. Sell $120. GONSET TUNERS #3012 and #3011. (152-162 M.C.) and (40-50 M.C.) respectively. Receive police, fire, mobile telephone, ambulance services, highway patrols, F.B.I., etc. Illuminated dial, squelch, etc. $65 each. All F.O.B. Richard M. Jacobs, WAØAIY, 1015 Glenside Place, University City, Missouri 63130. (314) WYdown 1-1941.

INDEX TO ADVERTISERS

Propagation Chart

February 1966

J. H. Nelson

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	7	7	7	7	7	7	7#	14	14	14	14*
ARGENTINA	14	7*	7*	7	7	7	14	21	21	21	21*	21
AUSTRALIA	14	7*	7#	7#	7	7	7	14	14	14	14	21
CANAL ZONE	14	7	7	7	7	7	14	21	21	21*	21*	21
ENGLAND	7	7	7	7	7	7*	14	14	21	14	14	7*
HAWAII	14	7#	7#	7	7	7	7#	7*	14	21	21	21
INDIA	7	7	7#	7#	7*	7#	14	14	14	7#	7#	7
JAPAN	14	7*	7#	7#	7	7	7	7	7#	7#	7#	14
MEXICO	14	7	7	7	7	7	7	14	14	21	21	14
PHILIPPINES	14	7#	7#	7#	7#	7#	7	7	7#	7#	7#	7#
PUERTO RICO	7	7	7	7	7	7	14	14	14	14*	14*	14
SOUTH AFRICA	14	7	7	7#	7#	7#	14	21	21	21	21	14
U. S. S. R.	7	7	7	3*	7	7#	14	14	14	7#	7#	7
WEST COAST	14	14	7	7	7	7	7	14	14	21	21	21

CENTRAL UNITED STATES TO:

	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	7*	7	7	7	7	7	7	14	14	14	21
ARGENTINA	14	7#	7#	7	7	7	14	21	21	21	21*	21
AUSTRALIA	14	14	7*	7#	7	7	7	14	14	14	14	21
CANAL ZONE	14	7	7	7	7	7	7*	14	21	21*	21*	21
ENGLAND	7	7	7	7	7	7	7#	14	14	14	14	7*
HAWAII	21	14	7#	7	7	7	7	7#	14	21	21	21*
INDIA	7	7	7#	7#	7*	7#	7*	14	14	7#	7#	7
JAPAN	14	14	7#	7*	7	7	7	7	7	7#	7#	14
MEXICO	14	7	7	7	7	7	7	7*	14	14	14	14
PHILIPPINES	14	14	7#	7*	7*	7*	7	7	7	7#	7#	14
PUERTO RICO	14	7	7	7	7	7	14	21	21	21	21	14
SOUTH AFRICA	14	7	7	7*	7*	7*	14	21	21	21	21	14
U. S. S. R.	7#	7	7	7	7	7*	7*	14	14	7#	7#	7*

WESTERN UNITED STATES TO:

	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	21	14	7	7	7	7	7	7	14	14	21	21
ARGENTINA	21	14	7#	7*	7	7	7*	14	21	21	21	21*
AUSTRALIA	21	21*	14	14	14	7	7	7	14	14	14	21
CANAL ZONE	21	14	7	7	7	7	7	14	21	21	21*	21*
ENGLAND	7#	7	7	7	7	7	7	7	14	14	7*	7*
HAWAII	21*	21	14	14	7	7	7	7	14	21	21	21*
INDIA	7#	14	7*	7*	7#	7*	7	7	7*	7*	7#	7*
JAPAN	21	21	14	7*	7	7	7	7	7	7*	7	14
MEXICO	14	7*	7	7	7	7	7	7	14	14	14	14
PHILIPPINES	21	21	14	7	7#	7#	7	7	7	7#	7*	14
PUERTO RICO	14	7*	7	7	7	7	7	14	21	21	21*	21
SOUTH AFRICA	14	7	7	7*	7*	7	7	14	14	21	21	14
U. S. S. R.	7#	7#	7	7	7	7*	7*	7#	14	7#	7*	7#
EAST COAST	14	14	7	7	7	7	7	14	14	21	21	21

Very difficult circuit this hour.
* Next higher frequency may be useful this hour.

Good: 1-3, 7-8, 10-12, 16-19, 23, 24, 26

Fair: 4-6, 14-15, 20-21, 28

Poor: 9, 13, 22, 25, 28

VHF DX: 9, 23-26

73 Amateur Radio

MARCH 1966
An Abominable 50¢

73 Magazine

Wayne Green W2NSD/1
Publisher

Paul Franson WA1CCH
Editor

March, 1966

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Cover by Bob Taylor.

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de W2NSD/1

never say die

Now What?

Several of the national radio societies in Europe, discouraged at the head-in-the-sand attitude of the League, had turned their hopes toward the International Amateur Radio Club, the IARC, which had been formed by officials of the I.T.U. (International Telecommunications Union). Now, with the IARC virtually scuttled by the Afro-Asian take-over of the ITU, no one knows where to turn.

There is the possibility that the International Amateur Radio Union Region I will free itself of the Old Man of the Sea in Newington who has so far kept it weak and impotent. The IARU is a loose union of European radio societies which has been working together on mutual problems. Unfortunately for the IARU its headquarters are in Newington and the League has been rather successful in preventing the growth of this threat to their omnipotence.

Many of us are looking very hopefully to the Institute of Amateur Radio not only for the safety of amateur radio in the U.S., but world wide. Amateur radio has gone for some fifty years now with absolutely no representation in our country and it has lost at every conference. The future of the Institute is up to you . . . and the future of amateur radio looks to me as if it is riding on your support of the Institute.

What can the Institute do that will help? First of all it can keep amateur radio alive in the minds of our representatives in Washington. If we have the Senate and House behind us we not only will protect ourselves in our own country, but we will be sure to have our representatives behind amateur radio at the conference tables in Geneva. I was present at Geneva at the last conference and I tell you now frankly and openly that the U.S. government did not have any intention of supporting amateur radio at that conference. Only a miracle saved us from catastrophe.

The miracle that saved us was the putting off of frequency reorganizations until the next conference. No miracle can save us next time because the whole purpose of the conference will be the redistribution of frequencies. As it stands right now amateur radio will go into this conference with a small handful of friends and a host of enemies . . . and these enemies include the biggest of them all: our own government.

If every active amateur sent the Institute $5 a year for the next three years I think we would have a good chance of getting our point across and ending up with usable ham bands. I'd give it a 75% chance. The way things are going right now it looks like we have a 5% chance of coming out reasonably well.

After talking this problem over with the heads of several national radio societies and many seriously interested and knowledgeable amateurs the best course of action, after making sure that our government is firmly behind us, is to actively tackle the problem at is weakest point: the African and Asian countries.

First of all it has been proposed that the Institute send illustrated information sheets on the values of amateur radio to small countries directly to the heads of these countries as well as their communications chiefs. This literature would emphasize the value to small countries of encouraging amateur radio and the help that the Institute is prepared to furnish those interested. It would point out that it is only when an amateur radio population has been established in a country that any sort of electronics industry is at all possible . . . and no country anywhere can grow even a little without electronics and communications. Amateur radio is one of the most important keys to the starting of a large growth of a country. The Arabs may hate Israel, but they won't overlook the fact that the hams there were of critical importance in the setting up of the country and the rapid industrialization of it.

Amateur radio not only encourages electronic industry to be formed in a country, but also provides men with the know-how to set up communications. Modern civilization rests firmly on the telephone.

How about tourists? Ham radio can help considerably for each amateur in a country is a valuable good will ambassador. Thousands of us travel all around the world visiting amateurs that have asked us on the air to drop in. Countries without amateur stations may get a one-man DXpedition once every ten years, but those with active amateurs draw

a lot more visitors. Ask any DX amateur how many fellows have visited him during the last years or so . . . you'll find the number surprising . . . and so will the tourist. Of course this spreads too for once back home we show our slides and movies to our local Rotary Club and before long many more people are thinking of visiting what was before an unknown country.

The Institute would like not only to approach foreign governments by mail, but to send "Ham Corps" groups to these countries to personally talk with these men and offer to set up a ham station and train some of the locals to operate it. Several manufacturers have indicated that they would be glad to support such a program and we have already had letters from many amateurs who are willing to work on such a project at no pay. I believe that we could organize a number of two and three man groups to visit the smaller countries who will have an effect on the course of the ITU all out of proportion to their size and sell these governments on amateur radio for their country.

DXing

For some time now I've been hinting that I'd like to encourage DXing a bit in 73. The question has been just what we could do that would be the best. I certainly didn't want to turn out another DX column like the ones in CQ and QST, that's for sure.

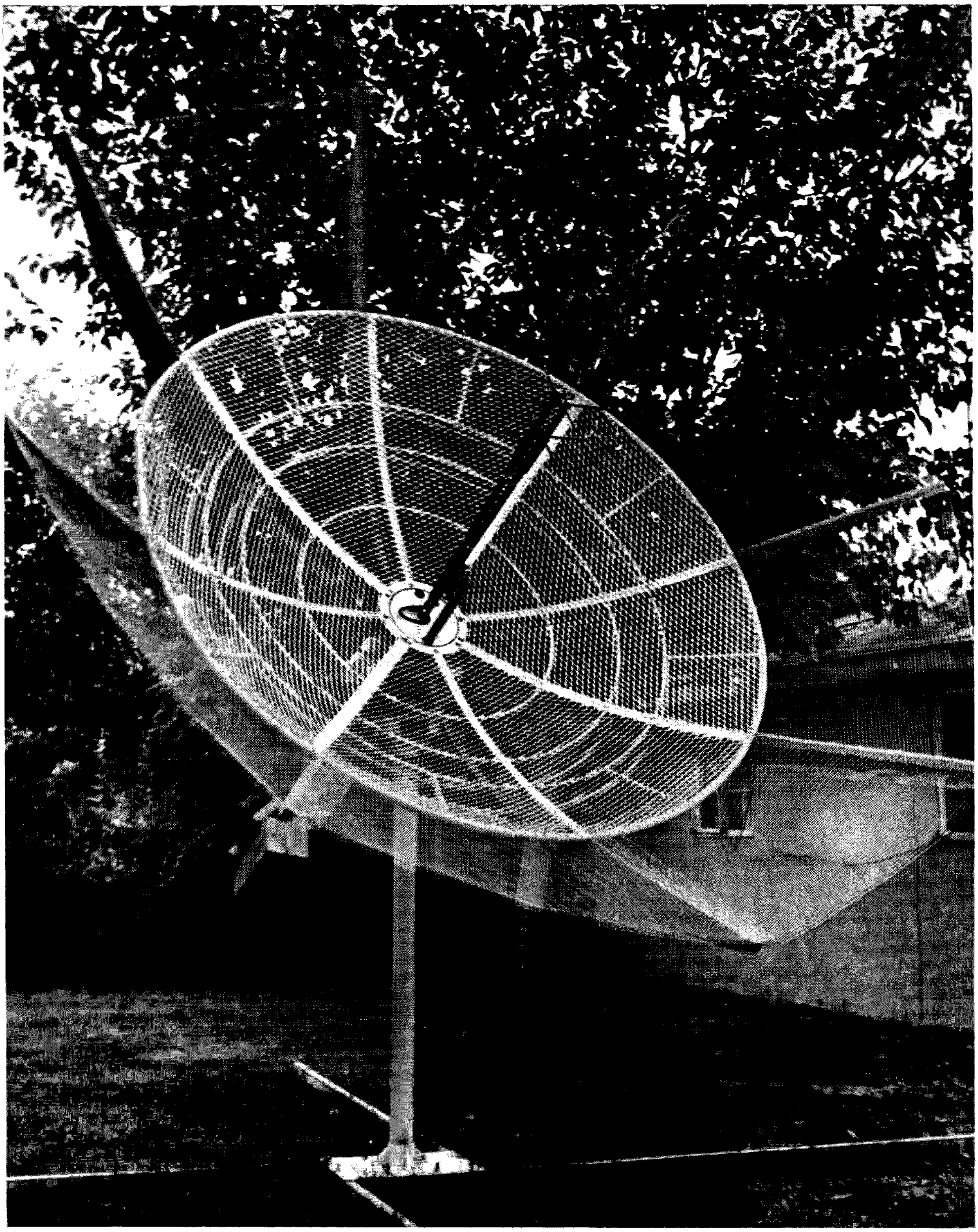
There has been considerable grumbling over certain deficiencies in the QST listings and, after considerable discussion with Gus, Stu W2GHK, and other DX luminaries, perhaps we have an answer. The recent decision by QST to do away with phone DX listings in the Honor Roll and other changes certainly emphasizes the already apparent problems of the DXCC.

Our solution is to plunge seriously into the DX Certificate game.

The One Hundred Country Award Certificate will be available from 73 starting this summer. We will also have available Two Hundred Country, Three Hundred Country and Worked The World Three Hundred and Fifty Country Award Certificates.

Gus, W4BPD, who will be in charge of the project, will give you the full details on the rules. Roughly, here are the basic features: *Countries* Countries accepted by QST, RSGB, REF, DARC and certain other national amateur radio societies will be accepted as "countries."

(continued on page 86)



Thirteen foot dish with reversible sense feed system installed. Photos by Joe DeYoung.

Circular Polarization

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For a number of years, the use of circular polarization has been fairly common in some areas of professional communications. The utility and often the necessity of this type of wave propagation in communicating with satelites and space probes has long been established. Further, at least some types of tropospheric paths seem to demonstrate greater reliability when circular polarization is employed.

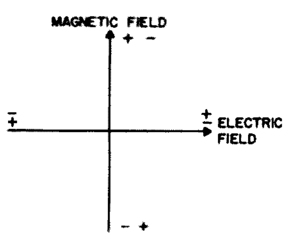
Until fairly recently, however, circular polarization had offered very little advantage over the common linear polarizations in general use, as far as the amateur operator was concerned.

The state of the art is advancing, though, and increased interest in moonbounce, UHF trops and OSCAR, may well lead to a much wider use of this mode among the amateur fraternity as, in each of these areas, circular polarization can, at times, provide superior communications.

Most VHF operators are familiar with horizontal and vertical linear polarization and the substantial signal loss associated with "cross" polarization. This is the result of certain characteristics of the electro-magnetic wave, which will be reviewed in a moment. In moonbounce, particularly on the frequencies below 1296 mc, a phenomenon called "Faraday rotation" can cause the plane of polarization to be shifted or rotated as the signal passes through the ionosphere on its way to and from the moon. This can be a real nuisance as a "horizontal" signal may produce a more or less "vertical" echo and, hence, the echo may be greatly reduced in strength or, perhaps, not heard at all.

The signal transmitted by a spinning or tumbling satelite may vary from horizontal to vertical in a rapid and often complex fashion causing flutter and fading in linear receiving systems.

Polarization can also be shifted by atmospheric and terrain conditions over a long tropospheric path. This can be anything from a permanent to a rapidly changing condition and, hence, its effect can vary from a constant signal of reduced strength to a signal with rapid QSB.



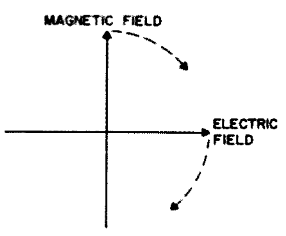


Fig. 1. End view of electromagnetic wave.
Fig. 2. Rotation of fields in a circular wave.

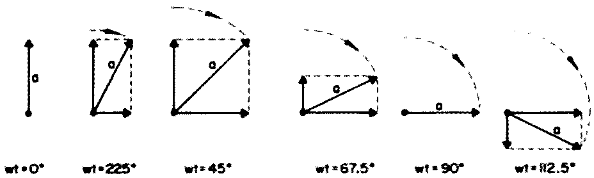


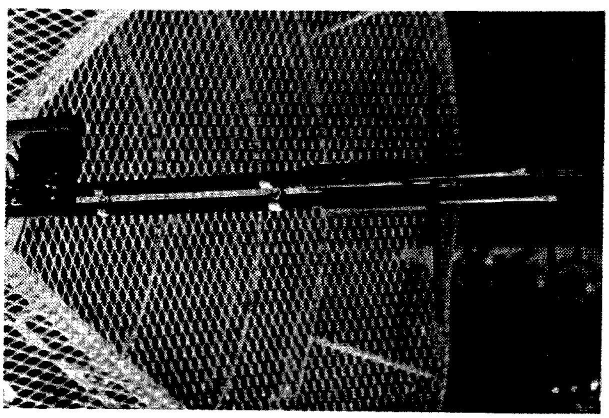
Fig. 3. Synthesis of circular polarization from vertical and horizontal polarization. Those w's are really ω's.

To begin a discussion of circular polarization and how it can be of use in some of these situations, it seems appropriate to start by reviewing some of the facts concerning the electromagnetic wave—the radio signal on its way through space.

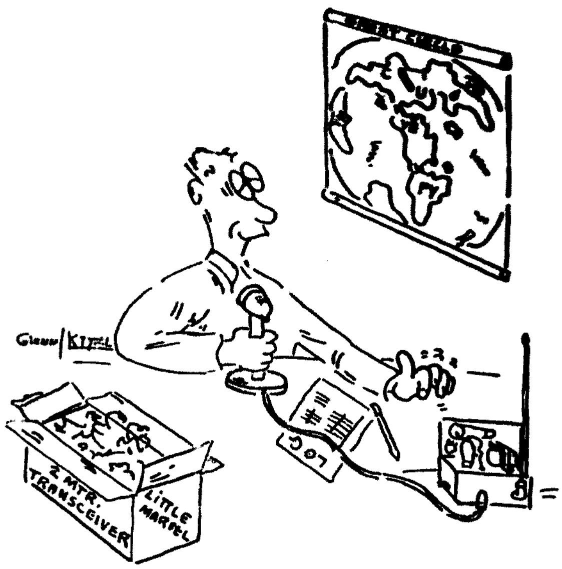
A radio wave is composed of two different types of fields traveling together. These composite fields, one, an electric field, the other, a magnetic field, travel in the same direction, but are oriented at right angles to each other. **Fig. 1** shows a diagram of how this might look if we could see the "lines" of force. The direction of wave travel in this diagram is straight up out of the page.

In linear polarization, the direction of the two fields remains constant and the amplitude changes from plus to minus and back again at a sine wave rate at the RF frequency. The polarization is said to be horizontal, if the electric field is horizontal; and vertical, if the electric field is vertical. Of course, it can also be diagonal but this is not commonly used.

If such a signal is to be received, it is necessary that the antenna "tap" one of these fields to remove the energy and convert it into an RF voltage for the receiver to detect. It is only necessary to tap one field, as energy from the other changes to the field being tapped as the tapped field's energy is depleted



Close up of twin boom type of reversible feed.



Well now. Ready to go. Guess I'll start with Australia.

by the antenna and hence almost all the energy is available to the receiver.

Some antennas tap the electric field and others the magnatic field. For instance, the simple dipole taps the electric field while the loop antenna taps the magnetic field. For the purposes of this discussion, however, we will consider only antennas that tap the electric field, though the principles involved apply to both types.

Cross polarization occurs when an antenna cannot "see" the field it is designed to tap. A dipole must be in the same plane as the electric field in the incoming wave. As the angle between the electric filed and the dipole increases from 0° toward 90°, the amount of field the dipole "sees" becomes progressively less and less until, at 90°, their is no component of the electirc field which lies in the same plane as the antenna and hence no voltage is induced at all, or stated mathematically, the voltage induced on the antenna:

$$e - E \cos \Theta$$

where Θ is the angle between the two antennas, and E is the magnitude of the wave electric field.

We now have a rough picture of what is happening in a linearly polarized radio wave and how it affects a receiving antenna.

The twist

As mentioned before, the direction of the fields, in a linear wave, remain fixed and only the amplitude changes. A circular polarized wave, however, is just the opposite. In it, the amplitude of the two fields remains constant and the direction of the fields always remain perpendicular to each other, but togethr, they rotate, making one complete revolution each RF cycle, as shown in **Fig. 2.**

Just how this comes about is a bit more complicated than linear polarization. This is due to the fact that a circular polarized wave is actually a composite of *two* linear waves. It is the result of horizontal and vertical linear waves 90° out of phase. **Fig. 3** shows this as a series of "snapshots" of the two electric fields through a little more than the first quarter of a cycle. Don't confuse this with the earlier diagrams. Both the fields shown are electric fields; the magnetic fields are present, but have been omitted from the diagram for the sake of convenience. It will be noted that both of these fields are changing in amplitude, as they are linearly polarized, but, also notice that, because of the 90° phase defference, the composite amplitude—the vector sum—of the two fields is constant and rotates from horizontal to vertical in a circular fashion once per RF cycle.

For those who prefer a mathematical explanation: the vertical component $y = a \sin \omega t$; the horizontal component $x = a \sin (\omega t + 90°) = a \cos \omega t$; where a = constant and ωt = RF phase angle.

The amplitude of the resultant field:

$$\begin{aligned} |A| &= \sqrt{a^2 \sin^2 \omega t + a^2 \cos^2 \omega t} \\ &= \sqrt{a^2 (\sin^2 \omega t + \cos^2 \omega t)} \\ &= a \end{aligned}$$

and since $|A|$ is constant as ωt goes from 0 to 2π the field vector rotates in a circular fashion about the origin.

It has probably occurred to many that there are two possible senses or directions for the fields to rotate, either to the right or to the left—clockwise or counterclockwise. This is, in fact, the case and hence, there are two kinds of circular polarization: right hand sense and left hand sense. If the sense is right hand, the field rotates clockwise as viewed from behind the wave; that is, it rotates the same way a right hand screw does when it advances.

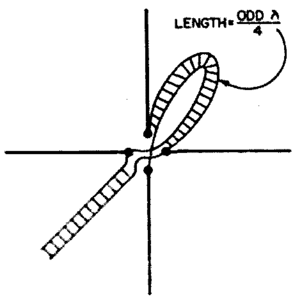
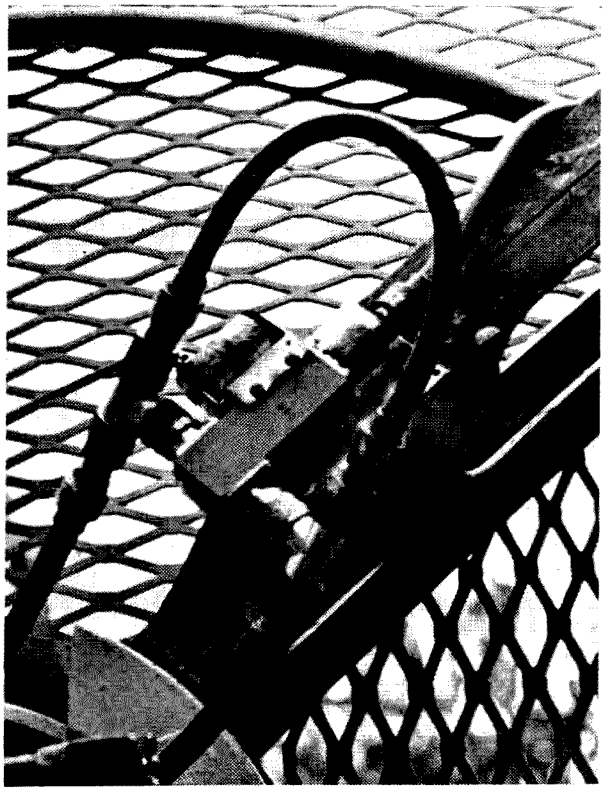


Fig. 4. Fixed circular polarization from two dipoles.



Sense reversing relay and delay line mechanism. Dipole feed lines are on the left and the input line on the right.

Though it is impossible to be cross—polarized with circular polarization, it is possible to be "cross-sensed." If this occurs, one of the two linear components of the wave is out of phase and hence, cancellation takes place. In other words, right hand systems don't receive left hand signals and vice versa. This can present some of the same problems as cross polarization, though as we shall see in a moment this can be easily circumvented, if necessary.

There are at least two practical ways to generate a circular wave, one common way is to synthesize it continuously with a helix. The helix can provide high antenna gain and be quite effective, though, the single bay helix is less versatile than another method about to be described.

The second method is to synthesize the wave by gathering and combining its component parts, that is, two linear polarized signals oriented at right angles and 90° out of phase.

The simplest way to do this is to co-locate two dipoles at right angles on a common boom in the form of plus sign. If these dipoles are fed with feed lines which differ in length by some odd multiple of a quarter wave length (90°), as in **Fig. 4,** then the dipoles will emit a circular polarized signal. If gain is wished then plus sign reflectors and plus sign directors can be added to the boom to form a yagi or broadside array.

As mentioned, this type of array can be very versatile; for instance, if both left and right hand polarization is desired, it is only necessary to provide for the reversing of the phasing, as shown in **Fig. 5.** In fact, with suitable switching, it is possible to have horizontal or vertical linear, or, right hand or left hand circular polarization from the same antenna at will.

As the circular wave is made up of two linear components, it is possible to work between a circular antenna and any linear antenna in any plane without cross polarization taking place. There will generally be a 3 db loss between the two types of systems as only half the power in the circular signal is contained in the particular linear component that the linear antenna is receiving.

If the path is causing polarization shifts, as in the trops circuits previously discussed, circular polarization, on even one end of the circuit, would improve the range of QSB and often will increase the average signal level. Circular antennas on both ends would do the same without inflicting the 3 db loss.

In moonbounce circuits, circular polarization eliminates the effect of Faraday rotation. The further rotation of a wave, that is already rotating inherently and received on an antenna designed to receive rotating waves, has no effect at all. In other words, you can turn a circle around to your heart's content and it still looks like a circle.

There is a problem, however, in moonbounce circuits and others involving signal reflections. A circular signal reflected by a passive reflector, such as the moon will return as a reverse image much the same as light images reflected by a mirror. The sense will reverse; the right hand becomes left hand and vice versa. The solution to this problem is

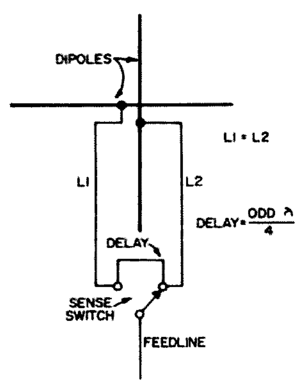


Fig. 5. Switchable sense configuration for both right and left sense.

simple, however. It is only necessary to wire the sense reversing relay, on a switchable plus sign array, into the antenna change over circuits and transmit in one sense and receive in the other.

KP4BPZ utilized circular polarization in the Arecibo moonbounce experiments in 1964 and 1965. The system in use there transmitted right hand in space and received left hand in space.

The switching technique, using the scheme shown in **Fig. 5**, was used at K6MIO in the second 1965 KP4BPZ 432 mc moonbounce test. It showed substantial increase in received signal over the first 1965 test in which linear polarization was used by K6MIO.

The feed array for the 13 foot (4 meters) dish used in the tests is shown in the photographs. As the booms for the antennas are pieces of rigid coax—the feedline—it was not practical to use the same boom for both dipole—reflector arrays. The separate arrays where placed as close together as possible and fed with equal feedline lengths to the sense relay. The delay line at the sense relay was ¾λ and the relay was wired into the antenna change over circuit.

The dish feed itself transmits left hand which, when reflected by the dish, becomes right hand (in space) and vice versa on receive. In this way the system matched the polarization used by KP4BPZ.

Reversing the sense sequence did, as predicted, result in a very substantial signal loss as "cross sensing" took place.

Summary

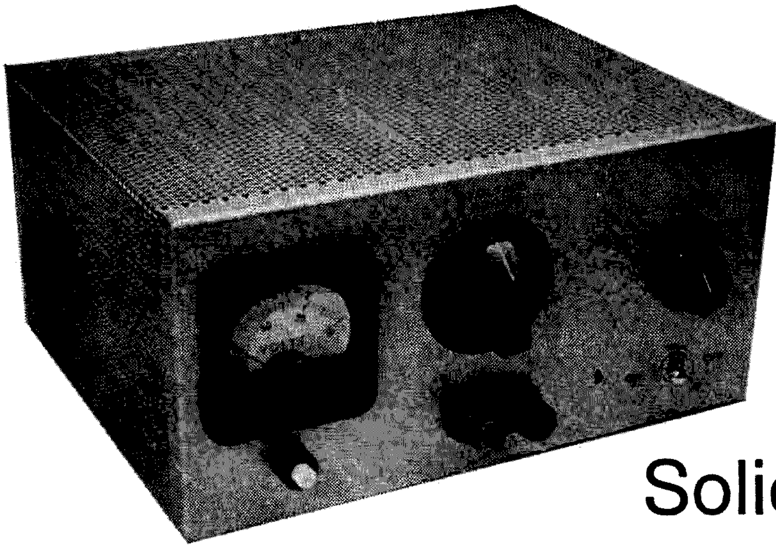
To recap this discussion; circular polarization occurs when the instantaneous electric and magnetic field amplitudes in an electromagnetic wave remain constant and the direction of the field vectors rotate from 0° to 360° constantly, making one full revolution per rf cycle.

There are two possible directions or senses for rotation to take place, either right hand or left hand. Right and left hand systems are incompatible on the air, but antenna can be easily designed to make use of either one at will.

The fields can be made to rotate the prescribed manner by at least two methods (actually there are several more). One method is to force the fields to rotate by combining two sets of fields at right angles to each other and in phase quadrature (90° phase difference).

Finally, and perhaps most important, it really works.

. . . K6MIO



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Solid State Sixty

The radio amateur today cannot help but notice the wide variety of semiconductor devices being advertised in 73 and other electronic orientated magazines. These devices, selling at a fraction of their original cost, were unheard of a few years back. For the ham who likes to build and experiment with these fascinating items, I will describe an adjustable, regulated, solid state power supply which is both easy to build and use.

Basically the unit consists of two supplies. T_1, T_2 and their associated circuitry make up the main, heavy current carrying supply. T_3 and its associated circuitry serves only to provide amplifier chain Q_1, Q_2 and Q_3 with a well-regulated reference voltage. Both supplies are common series type regulators, with Q_1 and Q_4 being the regulating element for each. Amplifiers Q_2 and Q_3 are included to isolate O_1's base from the 5K pot, so that only a small current is needed at Q_3's base to swing

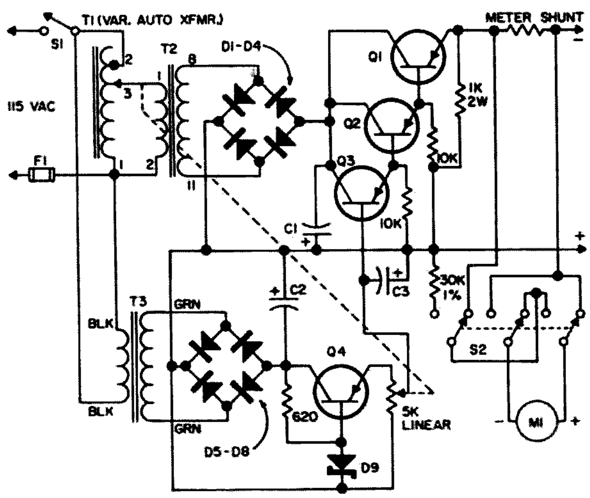


Fig. 1. Schematic of the solid state 60 watt power supply.

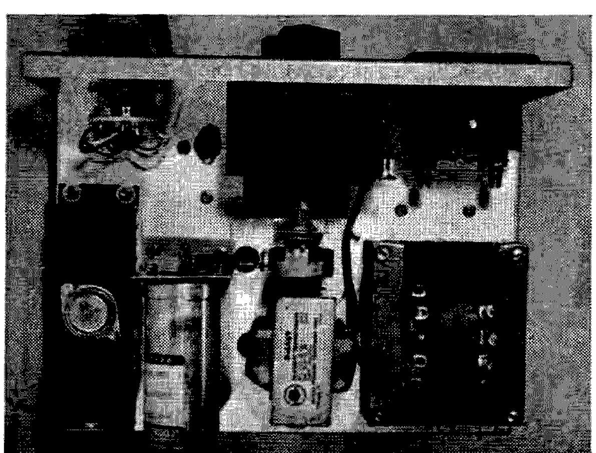
the large base current at Q_1. A close look at the diagram will show that all the transistors are being operated as emitter followers, or current amplifiers. The output from diode bridge D_5-D_8, after being filtered by C_2, is applied to the collector of Q_4 and the 620 ohm resistor. The 620 ohm resistor is picked to fire zener D_9 with about 10 ma of current. The zenor voltage is applied to the base of Q_4 and appears at the emitter, minus the .6 volt or so drop associated with silicon-type devices. The 5K linear pot serves as the emitter load and by tapping up and down this resistor, a voltage of from 0-33 volts approximately is available to control amplifiers Q_3 and Q_2. Autotransformer T_1 is coupled mechanically to the shaft of the 5K pot. This is done so that no matter what the voltage of the unit is set at, the drop across Q_1's collector to emitter is constantly 5 or so volts. If this were not done, using the unit at say 9 volts would require the series element Q_1 to dissipate the voltage difference between 9 volts and the total voltage that would appear across C_1. The voltage across C_1 is about 40 volts without the autotransformer so we have 40 minus 9, or 31 volts times the rated current of 2 amp, or a dissipation of 62 watts. Since the output rating of the supply is 60 watts (30 x 2) we see that more wattage is being used to heat the shack than is available for our bench projects. Putting T_1 in ahead of T_2 modifies the voltage available at C_1 so that approximately 5 more volts is available at C_1 than is supplied to its base by the reference supply. So the dissipation of Q_1 is 5 x 2 or 10 watts, and this is just lukewarm. Since most transistor projects require considerably less current, unless you are power minded, the unit will run at room temperature.

Construction and parts placement are not critical. Two items to watch for are that the 5K control pot has a linear taper and to use #16 or better wire for the high current carrying half of the supply. I used a California Chassis type LTC-464 cabinet and had to squeeze a little, but a larger cabinet will do nicely. Q_1 is mounted on a Delta Heat sink NC-401 and the sink insulated from the chassis, or insulate the transistor from the sink if you want. Q_2 is mounted under C_1 and insulated from the chassis with a mica insulator.

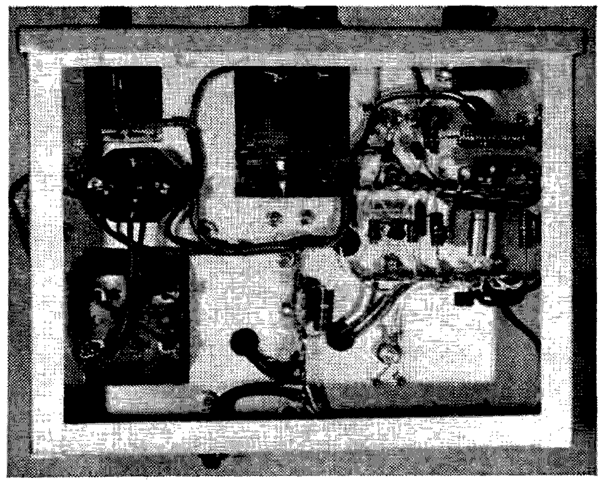
The photo of the top of the chassis shows the method of coupling the 5K pot to the autotransformer. I used a quarter-inch shaft coupling fastened with epoxy cement to the wiper of the autotransformer and supported the pot with a bracket made of sheet aluminum. Series regulator Q_4 and its socket can also be seen in the top view mounted between the autotransformer and the meter range selector switch. The coil of wire shown in the bottom view near the front of the chassis is the meter shunt. A good starting place for a 1-ma meter is about 1-¾ feet of #16 enameled copper wire.

A new meter face was inked on white paper and glued to the existing face. The new ranges are 0-30 volts and 0-3 amperes. I intentionally extended the current scale to 3 amperes, for as we all know, hams are notorious for drawing more than the rated current from transformers for short periods of time.

To adjust the pot and transformer, set them initially at their maximum voltage positions. Do this without the AC plug in. Lock the pot shaft to the autotransformer. Bring the pot and transformer back to zero and plug the supply into the AC outlet. Put a voltmeter across the collector to emitter of Q_1 and turn the switch on. Set the supply for about 10 volts output and



Top view of the power supply. The autotransformer is in the center at the top, coupled to the variable resistor below it.



Bottom view of the supply. The black object in the left center is a full wave rectifier.

note the reading across Q_1. If it is anywhere from 4-6 volts, you are in business; if not, turn the switch off and not disturbing the pot or transformer unlock the shaft. If the voltage drop was higher than 6 volts, hold the pot shaft from turning and move the wiper of the transformer about ¼" back toward its zero position and lock the shaft. If it was lower, move the wiper up about ¼" toward its maximum voltage position and lock the shaft. Turn the unit on and again measure across Q_1. Continue to do this until the correct voltage drop is achieved.

As for procuring the parts, if you buy new it is going to cost you. Meshna, who advertises in 73, sells a transistor suitable for Q_1 already mounted on the proper heat sink for a buck and a half. Poly Paks, who also advertises in 73, has the 2N1132's at a reasonable price, and a look through their ad should find the necessary bridge rectifiers and zener diode. As far the transformers and other parts, you are on your own.

. . . K3LCU

Parts List

T_1 —	Superior Powerstat type 10B
T_2 —	Stancor type RT-202 or Allied No. 62-G-332
T_3 —	Stancor type P-6469 or Allied No. 61-G-421
D_5, D_6, D_7, D_8 —	100 PIV 100 ma diodes or better as: Texas Inst. 1N537 or Motorola 1N4002
D_1, D_2, D_3, D_4 —	3-5 amp 100 PIV diodes or better: GE 1N3569
Q_1, Q_2 —	Motorola 2N376A
Q_3, Q_4 —	Motorola 2N1132
D_9 —	33 volt 1 watt zener diode Sarkes Tarzian VR-33
C_1 —	1500 μf 50 volt capacitor Sprague TVL-1341
C_2, C_3 —	100 μf 50 volt capacitor Sprague TVA-1310
M_1 —	1 ma meter
S_1 —	SPST switch
S_2 —	3 pole 2 position rotary switch
F_1 —	1 amp fuse

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Crystal Oscillators: Tube, Transistor and FET

Most standard crystals, surplus or otherwise available inexpensively, are for vacuum tube circuits. If used in transistor oscillators, these crystals usually oscillate on slightly different frequencies than marked, since most transistor circuits operate at low impedance levels unlike tube circuits.

Transistor crystal oscillator circuits fall into two categories: those which operate near the series resonance of the crystal (f_s) and those which operate near the parallel resonance of the crystal (f_∞). These operation points are illustrated in **Fig. 1.**

Several oscillators of the series resonance type are shown in **Fig. 2.** Note that in each circuit, if one were to remove the crystal, and substitute a blocking capacitor, the circuit would continue to oscillate at about the same frequency. That is, the crystal in the oscillating circuit looks like a small resistance.

The circuits that utilize the parallel resonance of the crystal all operate slightly on the inductive side of f_∞. Thus, these circuits are all, after they have been broken down to basics, Colpitts oscillators. Two examples of this type of oscillator are shown in **Fig. 3**; the only difference between them is that one is grounded-base and the other grounded-emitter.

If one picks the C_{be} and C_{ce} capacitances such that they yield 32 pf in series (or supple-

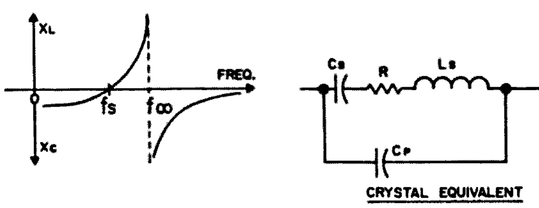


Fig. 1. Series (f_s) and parallel ($f\infty$) resonant points for crystals.

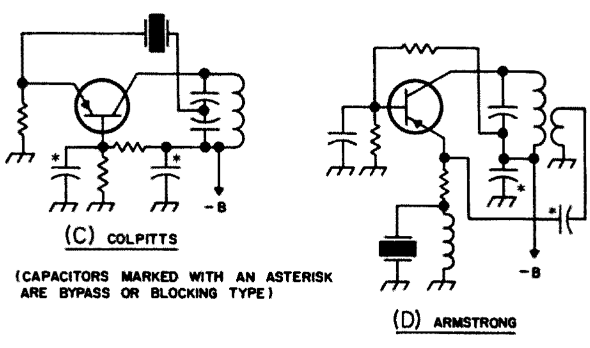
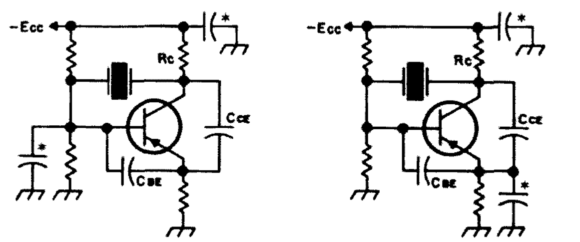


Fig. 2. Typical series resonant transistor crystal oscillators.



(CAPACITORS WITH ASTERISK ARE BYPASS OR BLOCKING TYPE)

(A) COLPITTS, CAPACITIVE DIVIDER FORMED BY Cbe AND Cce

(B) SAME AS (A) EXCEPT COMMON-EMITTER RATHER THAN COMMON-BASE

Fig. 3. Parallel resonant crystal oscillators.

ments them external to the transistor to give 32 pf) then the crystal will oscillate on its marked frequency in most cases. Of course, the voltage division ratio of C_{be} and C_{ce} must also be adjusted to give a feedback factor commensurate with the β of the transistor.

There are a host of other transistor crystal oscillators, which work to one degree or another. These, for the most part, are subject to adjustment and the individual transistor's characteristics, costing the designer the very stability he used crystals to obtain. Possibly the most satisfactory circuit for use with "32 pf" crystals is the very tube circuit for which it was designed—but replacing the tube with a field effect transistor. In this way, the impedance levels are of the same order and the circuit is readily dealt with by technicians experienced in tube circuitry.

For a short period of time, when FET's (Field Effect Transistors) were first introduced, their prices were quite high. However, although there are still some in the $50/each category, a number of reasonably priced FET's are available for experimenter use. Siliconix now has their U146 and U147 at about $3.00; these P-channel Silicon units are of the 2N2606 family.[1]

FET's can be thought of as near equivalents of vacuum tubes. The drain corresponding the plate, the gate to the grid, and the source to the cathode. This correspondence is a much better one than the collector-plate, base-grid, and emitter-cathode set for bipolar transistors and tubes. As in a tube, the current through the FET is controlled by the *voltage* between

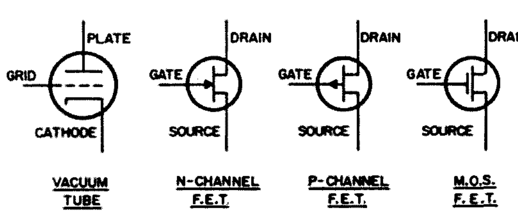


Fig. 4. Symbols for FET's and MOS FET's.

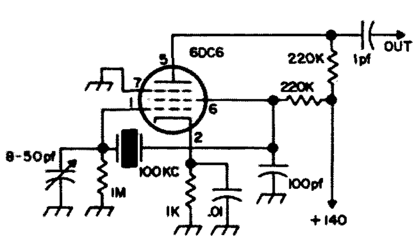


Fig. 5. Collins 100 kc calibrator.

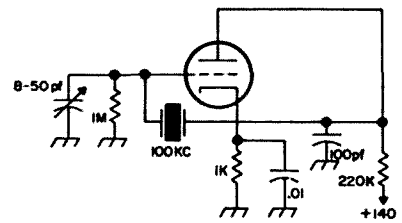


Fig. 6. Triode equivalent of Collins 100 kc calibrator shown in Fig. 5.

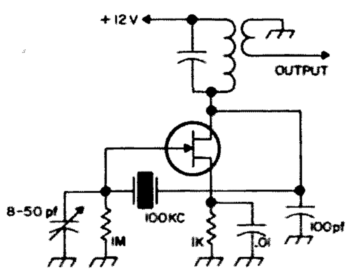
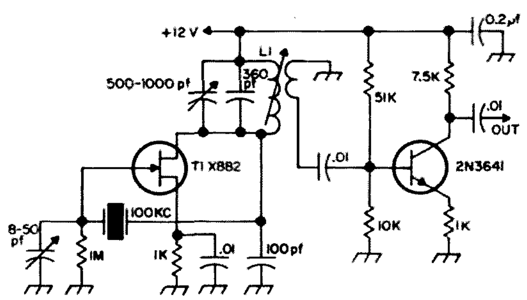


Fig. 7. FET equivalent of Fig. 6.



L1 = SIEMENS 54T1(O.L.) 1100N22 MATERIAL
38 T. PRIMARY, 4T. SECONDARY

Fig. 8. Isolation amplifier added to Fig. 7.

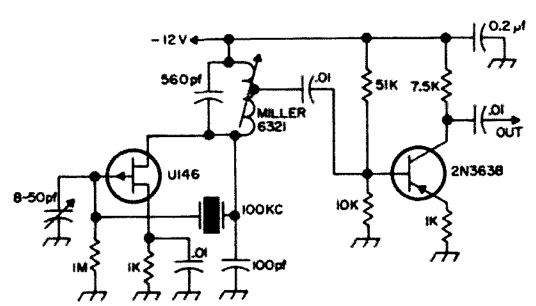


Fig. 9. P-channel FET oscillator and isolation amplifier.

the control electrode and source of current carriers. **Fig. 4** shows the representations of FET's along with a tube symbol to demonstrate the likeness.

The N-channel is most like the vacuum tube because one applies positive voltage to its drain and negative bias voltage to its gate for amplifier operation. The P-channel types are the other way around with negative voltage on the drain and positive bias. (The MOS types—which stands for Metal Oxide Silicon—are still rather expensive for amateur use.)

To illustrate how one can go directly from a well-established tube circuit to an equivalent FET circuit, let's steal the 100 kc crystal calibrator from the Collins 75S1. The original is shown in **Fig. 5,** and its triode equivalent in **Fig. 6** (we must draw the *triode* equivalent since we are going to replace the tube with a triode device). The only difference between these two circuits is that the output coupling of the original (electron coupling) has been left out. Let us now, again, redraw the circuit substituting an FET and lower the "plate" voltage a bit to suit the E_{dss} of the transistor, as in **Fig. 7.**

A parallel resonant circuit for the desired oscillator frequency is placed across the "plate" load to allow sufficient dc to flow and to make a low impedance tap available for output.

The 8-50 pf trimmer capacitor can be adjusted a bit for each crystal to bring the oscillation frequency right to that which is stamped on the crystal can. In most cases, the output frequency will fall within the crystal tolerance with no adjustment necessary.

Since we had to dispense with the electron-coupling method of deriving the oscillator's output, it would be well to add some output isolation to this FET equivalent. This can be done by adding an amplifier stage, using a conventional silicon transistor, as in **Fig. 8.**

In the above example, the FET used was a Texas Instrument TIX-882, a germanium FET which was available for about $3.00 several years ago. This type (N channel) was used to

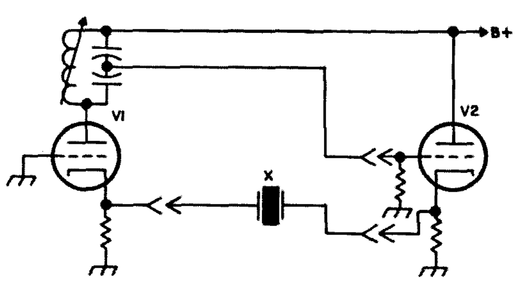


Fig. 10. A Butler oscillator as analysed by sections.

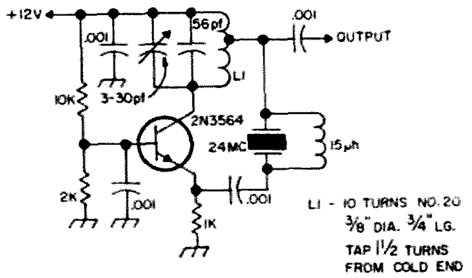


Fig. 11. In this circuit for crystals designed for series mode operation, an inductance is added in parallel to the crystal to resonate the holder capacitance and prevent spurious oscillation.

allow the tube-circuit-conversion example to use a positive supply, for illustration purposes only. The TIX-882 is no longer available, but a silicon N channel FET could be substituted.

Since it is the P channel devices that are now available inexpensively (U146 and U147), **Fig. 9** shows the circuit (again redrawn) for one of these.

The main intent in the foregoing section was to demonstrate how one can use FT 171, FT 241, FT 243, and similar surplus crystals with FET oscillators so that they oscillate as marked. However, in the more recently available surplus, there are some crystals which *are designed for* series-mode operation. Military types in the HC10/U (coaxial) case are for series operation: CR9 and CR 24. Also, many of the crystals in the HC6/U (hermetically-sealed metal cases with ½" spaced, 0.050" pins) are for series operation: CR19, 23, 25, 26, 28, 30, 32, 35, 45, 51, 52, 53, 54, 65, and 75.

Some of these crystal units were designed for tube type oscillators of the "Butler" type, but will work well in the type of oscillators shown in **Fig. 2.** The Butler oscillator achieves the low impedance driving source and low impedance input by use of a cathode-follower and a grounded grid stage respectively. The Butler oscillator is shown in **Fig. 10,** divided into its component sections. As can be seen, V_1 is a Colpitts Oscillator whose capacitive-tap does not return directly to the cathode but drives V_2, a cathode follower. V_2 drives the cathode of V_1 through the low series-resonance resistance of **X.**

This method of utilizing the series-resonance frequency of a crystal with a tube circuit is the "hard way," although an equivalent FET Butler oscillator could be built. It is far easier to use a single bipolar transistor oscillator like one of those in **Fig. 2.** An actual circuit is shown in **Fig. 11,** for a 24 mc crystal oscillator using a CR 24 coaxial crystal.

. . . W6GXN

Ed Baker WØEDO
9937 Truman Road
Independence, Mo.

Slaying the Monster

or: Why Fear TV?

WØKYQ wrote a fine book (Unfortunately out of print) describing a TV station which can be built for under $50.00. For many this book has already served as introduction to another fascinating facet of hamming.

Those of us who have been frightened by so many circuits completely alien to AM phone may be helped by the following description of how to rehabilitate an old TV set, for use as a station receiver.

If the receiver is to be viewed from close up the small screen of yesteryear is to be preferred to today's 29" living room sets.

Larger than 12" causes eye strain, while smaller than 7" gives too little detail. 10" is about the optimum. Most of these sets, fortunately, are still setting around in TV shops and basements waiting for us to collect them.

Wayne Pierce K3SUK

In selecting a set the main consideration is to make sure it has a power transformer, as the "series filament" sets introduce the same shock hazard as ac-dc table radios, even though they may be marked ac only. (This is due to a voltage doubler circuit in the power supply). Of course a set with picture tube is to be desired, but if it appears to be in good shape otherwise, a missing CRT is no reason to pass up a good deal. More on this later.

Once the set has been selected, proceed as follows, and little or no difficulty should be encountered.

If there is a chance that moisture may have gotten at the set place it under a 100 watt bulb over night before starting rejuvination. Start with a camel hair brush, and clean the set completely top and bottom. With the voltages involved, a single piece of lint can cause an arc, with possible damage to several components. Next look over the entire set carefully, and replace any tubular paper capacitors which show any signs of drying out or dripping. A good rule here is; when in doubt, replace it. An ounce of prevention is worth a pound of burned tubes and charred resistors. One word of caution, however, use exact values for replacement, and position them the same as the old part. Avoid moving parts unless absolutely necessary, then return them to their original position. The final step before applying power, is to take a good grade of solvent/lubricant (Quietrol, Spra-Kleen, etc.) and clean all switch contacts. The aerosol can is preferable, but a good job can be done with bottle and brush. Avoid using too much, as this will encourage accumulation of dust.

Do not touch any of the alignment adjust-

ments, as these are set for a wide band width, and require special test equipment. Even the experienced TV technician attempts realignment only when absolutely required. These circuits are quite stable, also quite broad, so no trouble should result if they are left untouched. (The one exception is turret tuners, described later)

If there is no power cord with your set one can be bought at your local TV shop. It is known as a "cheater," and costs $.25 to .50.

Apply power and observe closely for arcing. If an arc occurs, turn the equipment off and clear the cause before proceeding further. Look for tubes not lighted, or with a blue glow, and replace any observed. If a known good tube still glows blue trouble is indicated, and must be cleared. This does not guarantee all good tubes, but it is a fair start. If all is well attach an antenna, and set the controls to a local channel. Adjust the fine tuning for best picture, then adjust horizontal and vertical hold controls for most stable picture. The horizontal and vertical linearity can best be set when a test pattern is being broadcast. Call your local station for the times such a pattern can be seen. Horizontal and vertical hold controls may interact with others, so always touch them up when changing other settings. Horizontal and vertical size may be set on the test pattern also, and should be adjusted so that height equals ¾ width.

When dealing with TV keep in mind that voltages as high as 40,000 volts may be present, so always discharge everything with a shorting lead before reaching into a set, and if it becomes necessary to take readings while the set is turned on, keep one hand in your pocket.

Picture tubes require special handling, as they contain a high vacuum and have a large exposed area, but with proper care no undue hazard is involved. Never bump or scratch a picture tube, or allow any pressure on the neck. NEVER leave an exposed picture tube where children can reach it. Replacement CRTs are available, usually at reduced prices, for all sets 7" or larger.

The image on a 12" or 14" screen can be reduced to the size normally displayed on a 10" screen (approximately 6" x 8") in many cases merely by adjusting the size controls. When this doesn't work take a strip of aluminum foil 2" wide and wrap one or two turns around the neck of the tube and fasten with Scotch tape. Slide this into or out of the yoke until the desired size is obtained.

If the set originally used a large screen CRT (up to about 17") usually it can be directly replaced with a 10" or 12" tube. The things to be considered are: 1. Focus—If the original used a focus coil and the replacement doesn't, replace the focus coil with a 20 watt resistor of about the same resistance. If the opposite is true connect coil anl control as in the diagram, or install a permanent magnet focusing device. 2. Ion trap—This is a small magnet on a clip, and may be installed by snapping it on the neck of the tube. Adjust it by sliding it around until a point is found that will give maximum brightness. If two spots give good brightness, use the one closest to the base of the tube. 3. Deflection—The yoke will probably give too much deflection. Use the aluminum foil trick described above. 4. Base connections—If the base connections of the replacement differs from the original, simply rewire the socket.

A good source of small screen tubes and other parts mentioned above is the series filament sets which we rejected for conversion, or your local wholesale house.

If for some reason the old cabinet does not make a satisfactory mount, a professional looking panel can be fabricated from tempered masonite or similar material.

If your set has a step type tuner it has been aligned on all channels, since the coils are all in series, and adjustment of one channel interacts with all lower channels. However, if it has a turret type tuner each channel uses a separate coil, and the unused channels (which will be used as the *if* in a ham set) probably have never been precisely aligned. In most cases it will still be close enough to function, but the purists (and the screwdriver technicians) may wish to touch up this adjustment. This requires a reasonably accurate signal source, but a well constructed self-excited oscillator can be used. (77.25 mc for channel 5, and 83.25 for channel 6) In recent years manufacturers have aligned all channels, so we have a ready source of calibration for our oscillator. Tune the family TV to the nearest (in frequency) channel in use in your area, and adjust the fine tuning for best picture. Switch to the channel to be aligned and couple the oscillator to the set. Tune the oscillator until the screen goes black. Set the oscillator to the center of the tuning range that will cause a black screen. Now connect the oscillator to the set under test. Under the channel selector knob is a hole which gives access to the coil in use. Set the channel selector to the desired channel and adjust this slug for maximum blackness of the screen, with the fine tuning set to mid-scale. This completes alignment.

Let's make BCNU a literal expression on the ham bands. . . . WØEDO

Looking west from the front of the VP2VD shack. The high peak in the background is St. Thomas in KV4 land.

John Attaway K4IIF
P. O. Box 205
Winter Haven, Florida
Photos by K4CAH.

Diary of a DXpedition VP2VD

During the period October 21-24, 1965 a DXpedition was made to the British Virgin Islands by Dave Gynn G3SBP, Ernie Hendry K4CAH, and the author, K4IIF, operating under the call VP2VD. Although each had previously operated from DX locations, this was the first effort on a concentrated operation within a limited time period. Naturally many unexpected problems arose, all of which were at least partially solved, so that the expedition reached a successful conclusion. These humorous and not so humorous problems, and their solutions, comprise an interesting account which everyone who has dreamed or planned toward a DXpedition will find interesting and enlightening.

The planning period

December, 1962
The idea originated 3 years ago while standing on the front porch of the home of KV4BZ. It was a clear bright day, and Jost van Dyke, Tortola, and the other British islands to the east seemed very close.

January-February, 1963
Regular skeds were kept between K4IIF and Dick Spenceley KV4AA, the grand old man of the Caribbean. However, it was quickly found that although Danny Weil VP2VB, could easily obtain a license as a British citizen, for U. S. citizens it was another matter entirely. No license could be obtained and the idea was set aside.

July, 1965
Rumors began to circulate of a pending reciprocal operating agreement between the USA and the UK. A letter was quickly dispatched from K4IIF to old friend G2BVN, DX editor of the RSGB bulletin. "What gives, Steve?"

August 15, 1965
K4IIF de G2BVN: "—— an agreement is now being negotiated between the U. S. and the U.K. and it should not be too long. —sorry I cannot offer you an immediate solution John, but I'll be pleased to keep you posted."

August 28, 1965
Ernie K4CAH, signed on as 2nd operator.

September 9, 1965
Reciprocal licensing was still very indefinite, but KV4AA came up with an ace-in-the-hole. Dave G3SBP, ex 5N2RDG, engineer for Cable & Wireless Ltd in St. Thomas, was sweating out the reciprocal agreement from the other side. Meantime he might be interested in a VP2 operation. Letter contact was quickly made.

September 21, 1965
K4IIF de G2BVN: "—we saw representatives of our GPO at the end of last week and the news is that the form of application and the necessary paperwork and checking organization for reciprocal licensing should be operational by the end of October."

This made it definite that reciprocal licensing would be too late for us, so the licensing burden fell fully on Dick Spenceley's ace, G3SBP, but there was no problem as Dave wrote "I have applied for a VP2V call and hope to get confirmation of it some time this week."

September 22, 1965
We were sure of a ticket, but what about a QTH? We had not been ashore in these islands. A land line call to ARRL Director Bob Denniston, WØNWX, revealed that his favorite retreat, the Treasure Isle Hotel on Tortola, had power 24 hrs. per day. However, Bob cautioned that it was surrounded by high mountains and that propagation was poor.

September 23, 1965
G3SBP de K4IIF: "We are rounding up gear. —can you get a pole for the beam? How much trouble is it to get from St. Thomas over to Tortola?"

K4IIF de Treasure Isle Hotel, Tortola, BVI: "We are pleased to confirm your booking from October 21-24."

September 25, 1965
K4IIF de G3SBP: "Re the pole, we should be able to get something in Tortola even if it is only 2 x 4's. We can't carry a pole or mast on the boat. There are 2 boats daily to Tortola, the trip requires 2 hours."

K4IIF de K4CAH: "Looks like you too are burning up the typewriter. — I have been promised a triband beam and possibly a Xmtr and Rcvr."

October 4, 1965
K4IIF de G3SBP: "The ticket is in hand. The call is VP2VD. However, they specify 200 watts maximum so no linear. Can get a 20 ft. pole, 4 x 4, at 21¢/ft."

October 8, 1965
K4IIF de K4CAH: "The gear loan fell through. I will box up my own personal S-line and take it. Can't locate the man with the beam."

October 10, 1965
K4CAH de K4IIF: "W4DQS has sent me one of the SX-117s used at San Felix, and I will take my SBE-33 and TO Keyer."

October 15, 1965
K4IIF de K4CAH: "W4PJG has volunteered to be QSL manager. Still unable to locate the man with the beam."

October 16, 1965
W4PJG de K4IIF: Ur offer to handle QSLs is gratefully accepted.

October 18, 1965
Beam finally obtained but too late to check it out. The beginning of a serious problem.

The trip down, October 20, 1965

The only serious travel problem arose when we met at the Miami Airport and compared notes on the weight of our luggage. It appeared that the airline would soon be holding mortgages on our respective homes to satisfy the overweight charges. However, by putting some items in the baggage of Sonny McCoy, a prominent citizen of Ft. Myers, Fla. who was going along to see the country, and by carrying a few light weight items, such as the power supplies, on board as hand luggage, we succeeded in scraping by with only a $40.00 charge. We then resolved to make good use of air freight on the return trip.

After meeting Dave Gynn G3SBP, for the first time at the St. Thomas airport we adjourned to the latter's jeep, and with K4IIF sitting on K4CAH and Sonny McCoy sitting on the TH-3, we drove to the QTH of KV4AA for a pleasant reunion over beer and supper. After eating, everyone took a turn at the mike of KV4AA before turning in for our last good night's sleep for several days.

The next morning, October 21, we arose early, ate a good breakfast, then drove down to the waterfront in KV4AA's truck to catch the morning boat to Tortola. The trip was beautiful, V. I. scenery being second to none. On the way over we got our first view of the highest peak of Tortola, not knowing at this time what role this peak was to play in our later operations.

The operation begins—but with problems

On our arrival in Roadtown, capital of Tortola, we found that October 21 was the local patron Saint's day, and all businesses were

On the dock at St. Thomas preparing to board the Empress of Tortola bound for the British Virgin Islands. On the left is Sonny McCoy, with Ernie Hendry K4CAH and the gear to his right.

closed. Consequently we couldn't get the pole we had planned to use for an antenna mast. However, the hotel was more than cooperative and allowed us the use of its 20 ft. flagpole, the top of which could be reached from the roof. No ladder was available, but G3SBP solved the problem by walking across an adjacent wall and climbing vines onto the hotel roof. Unfortunately, Dave's arms and legs became casualties when the vines turned out to have thorns.

Shortly G3SBP and K4IIF had the dipoles for 40 and 80 meters up while K4CAH worked on the assembly of the beam. The other hotel guests stood around watching in amazement and the owner of the local radio station, call letters ZBVI, was attracted to the commotion. After investigating the scene she dispatched a jeep to the station to secure a tape recorder for an interview. A 15 min. interview was subsequently taped and broadcast at 6:30 PM on prime evening time, a thrill to the DXpeditioners to outweight world tensions in the local news.

However, after this interesting interlude our problems became really troublesome. As mentioned earlier we had not been able to check out the beam prior to departure, and we found that the boom to mast bracket and the clamp joining the two halves of the boom were missing. It was later found that these had been removed as a practical joke. Different people have different ideas regarding fun. Despair momentarily took over, but not for long as a Rube Goldberg arrangement of ropes and wooden wedges was devised which held well enough to support the beam.

At 1925 GMT the S-Line was tuned up on 15 meter SSB and KZ5AY was worked for the first QSO of the expedition. Contacts followed with W4LZ and WA4LUG on 15, then a string of YV's on 20 meters. However, contacts to stateside were virtually non-existent on 20 even after long CQ's. The reason appeared obvious. The beam was looking directly into the side of an 800 ft. mountain rising almost vertically between the hotel and the USA. A gap in the mountain allowed us to skip over to YV and KZ5, but Bob Denniston was right, propagation to the states was hopeless. We were ringed on 3 sides with only the southeast completely open.

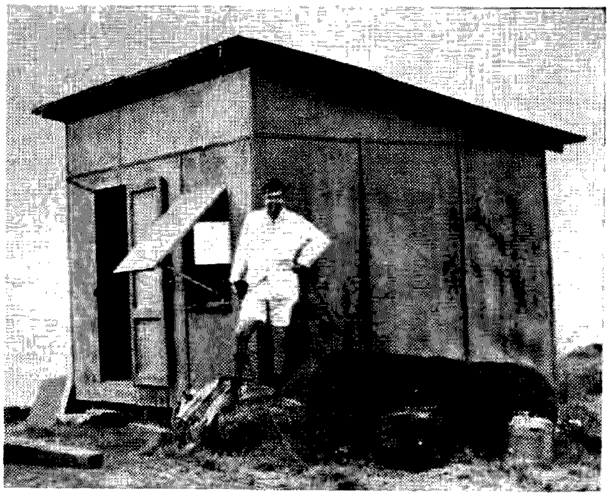
As daylight waned, Sonny and Ernie elected to climb the mountain in an attempt to find a solution to our dilemma. However, after 2 hours they came limping back into the hotel with nothing but bee stings, scratches, and the news that right behind this mountain was another one even higher. With this we QSY'ed to the hotel dining terrace for a delicious supper, typical of the excellent meals put forth daily by the Treasure Isle during our visit.

After supper K4IIF tuned up on 40 meter CW and kept a sked with Bill K4CK, in Auburndale, Fla. for the first CW contact. During the QSO the line voltage fluctuated so severely that the lights became very dim every 2-3 minutes. This rendered the automatic keyer almost inoperable as it went wild during the dips, sending dots when the dash lever was struck. We sounded like the worst lids on the band and finally had to go to a straight key. Afterward, 19, 40 meter CW contacts were made with the states and Europe before a violent thunderstorm forced us to QRT. During this time we had a pleasant visit with Row Roy VP2VA, proprietor of the hotel, who promised us help in the morning to get the beam higher.

The early morning 7 mc SSB sked with KV4AA, W8EWS, and K5JLQ was kept at 1150 GMT, following which, true to his promise, VP2VA arrived with a 15 ft. section of pipe, and shortly we had the flagpole extended higher. Everyone scurried to the rig, tuned to 14 mc SSB, and QSOs followed with W4ZYS, W4PJG, and numerous Central American stations. However, at about 1315 GMT the band quieted and we settled back to a pace of only 4-5 contacts per hour. At 1815 GMT K4KDN was worked keeping intact the record of contacts between Herb and K4IIF from every DX location visited by the latter to date.

We were now convinced that the DX'pedition would be a complete failure unless something drastic was done. The CQ DX Phone Contest was due to begin in a matter of hours and it would be our last chance to run up a respectable number of QSOs. Consequently, K4CAH set out to find a portable generator for rent while G3SBP called on John Horne of Cable and Wireless Ltd. for help in selecting a new QTH. John suggested looking at the site of a new tropospheric scatter station being constructed by Cable & Wireless Ltd. on the highest peak of the island, about 1500 ft. above sea level. They made a quick inspection trip and Dave returned ecstatic over the location which was unobstructed in all directions. The only disadvantage was the road, 5 miles of which were designated jeep only, daylight only.

In the meantime Ernie had found a generator for the "nominal" rent of $20.00 a day. We later found that it normally rented for $5.00, but the jolly Americans got a special price. Not impressed by the decrepit appearance and cough-sputter of the generator, it



The author beside the shack. Generator is in the foreground.

was decided to hedge our bet by splitting up. K4CAH and G3SBP went up the mountain with the S-line and dipoles for 20 and 80 meters while K4IIF remained at the hotel with the transceiver, SX-117, the beam which was not movable, and the 40 meter dipole.

Upon arrival at the top, Dave and Ernie quickly set up shop in a small wooden shed built as the construction superintendent's office. As soon as they tuned up on 20 meters they had a pileup. Whereas 5 contacts per hour were being made at the foot of the mountain using the beam, the dipole at the mountain top was yielding up to 2 QSO's per minute, alternating roughly 50-50 between stateside and DX. Contacts with Europe, N. America, S. America, Africa, and Australia were made in the first hour. The first stateside QSO was with Herb W4KET in Ft. Myers, with Jim WA4DDG, in Tampa right behind. Between 2015 and 2300 GMT over 250 contacts were made for an average of better than 80 per hour.

Contact was established with K4IIF at the hotel and plans were made to bring up the rest of the gear and some food. However, with sundown approaching no one could be found who was willing to tackle the road up the mountain with prospects of returning in the dark. Things looked discouraging until John Horne arrived at the hotel about 2200 GMT and agreed to take the Land Rover up one more time. The vehicle was hastily loaded and as a consequence the 40 meter dipole was left on the ground at the hotel. The only food which could be secured was a loaf of bread and some cheese plus a few cans of beer.

The Land Rover reached the summit at 2300 just in time to catch the last few minutes of the short tropical twilight. After quickly unloading John went back down the mountain leaving us completely isolated until the next morning, the nearest native cabins being about a mile away. However, that first evening must go on record as one of the most beautiful ever experienced. It was a dark, moonless night, and St. Thomas lighting up like a Christmas tree 20 miles away across the water, and the glow of the lights of San Juan 80 miles way will long be remembered.

The CQ phone DX contest, October 23-24

After 4 wonderful hours on 20 meters the band had begun to sputter and fade as 0000 GMT and the contest approached. However, we decided to stick with this reliable band and K4CAH took the first turn at the mike while G3SBP and K4IIF madly scurried around converting the 80 meter dipole to a combination 80-40 meter antenna by inserting insulators and jumper wires 33 ft. on each leg. This normally simple job was complicated by darkness interrupted only by weak light from a very sooty lantern. The band held up just long enough for us to complete the antenna conversion as Ernie logged in 9 countries in 5 zones during the first 16 minutes. These ranged from YS2SA in zone 7, our first contest contact, to OE5CK in zone 15.

Twenty really began to fold at this point and QSOs became few and far between. Consequently, the mike was relinquished to the author who QSYed to 7095 kc and went to work on the stateside pileup. The first contact was at 0049 GMT with WA2SFP. Over the next hour 31 contacts were made with W1, W2, W3, W4, W5, W8, W9, and VE. The going was slower than we had anticipated for two reasons, one being that we were frequently QRMed by other DX stations operating near 7095, and the other was the trouble in distinguishing the stations calling us from those calling other DX stations. Most of the DX was "listening 7200 up."

At 0200 another try was made on 20 meters but signals were few and weak, and only 2 contacts could be made so the insulators were jumped to convert the duoband dipole to 80. This job will long be remembered by K411F and K4CAH who climbed the wall of the partially completed building in pitch darkness to attach the necessary wires. It was resolved at this point to have a flashlight for the next night.

The first QSO on the 80 meter band was with W1AQH at 0246, after which 4 countries in 3 zones were worked in about 20 minutes. It was then discovered that the gas-

oline supply was diminishing at an alarming rate and would be exhausted before the morning band opening if not conserved. Accordingly, we shut down for an hour and attempted to rest on the floor of the shack with a roll of blueprints for a common pillow. Upon recranking the generator at about 0400 we found to our surprise that 20 meters was wide open to the midwest states. In a frantic hour from 0416 to 0516 K4CAH logged in 82 QSOs. These included 32 WØ's, 24 W8's, 13 W9's, 6 W5's, 1 W4, plus KP4, KV4, OD5, ZE1, VP2, and ZS4.

At midnight we got an unexpected visit from Colin Barnes, hotel Asst. Manager, and Peter Keen, English freelance photographer, who braved the mountain road in the dark to see that all was well with us. G3SBP elected to return to the hotel with them so that at least one of us would be rested for the next day's operations.

After 0530 the going got rough again on 20 meters and only 1 DL, 2 4X4's, and a VE were worked in a 45 minute period so at 0625 we again QSY'ed to 80 meters, and in 28 minutes worked 19 stations in 4 countries and 3 zones. At 0650 the gasoline supply had us really scared, however, and we shut down for a second time.

At 0907 we again went back on the air after a totally unsuccessful attempt to sleep on the hard floor. We logged in 9L1HX and ZS1DG on 20 meters before trying the 40 meter pile again at 0916. During the next hour we made 37, 7 mc contacts in 5 zones and 4 countries. The number of DX stations using this band and tuning "7200 up" again lowered our contacts per unit time ratio. The bedlam around 7200 kc must be heard from the DX end to be appreciated, and equally so the 3800 up segment, as almost all stateside stations are on these frequencies during the late night and early morning hours.

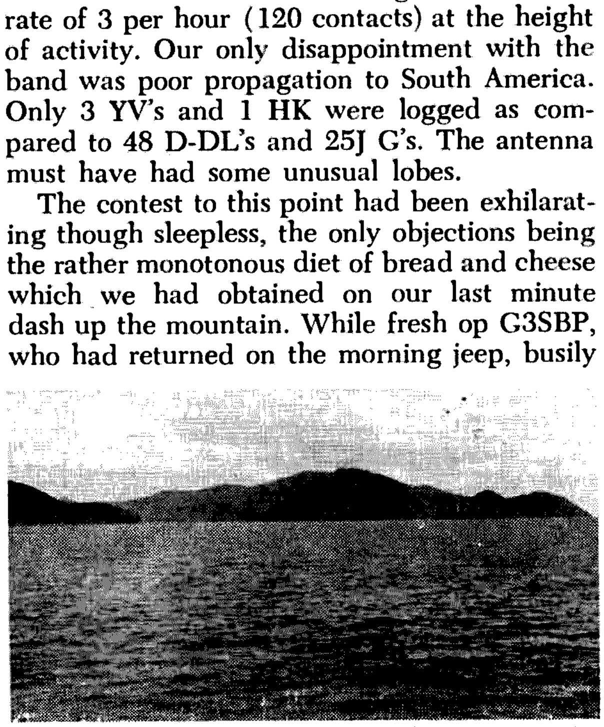
At 1028 we were again on 20 meters working LA3AF, after which 6 more countries in 3 continents quickly followed. To our surprise WA2SFP, who had been our first 40 meter contact, called us S9 at 1043 and the stateside parade was started much earlier than expected. The first from other east coast call areas thru the pile were W1BPW, W3AZD, and W4BVV. At 1058 W6HST was worked for the first 6 on 20 meters. At 1100 the Florida DX Club gang began to hit with rapid fire contacts by K4HNA, WA4NGO, WA4-DDG, K4SHB, et al. From 1043 until 1230 GMT 4 pages of log were filled at 40 contacts per page. These were mostly W, K stations, but many DX reliables such as GW3-NWV, OA4KY, KV4AA, HK4EB, YV5BIG, HC5CRC, and VP3HAG were also represented.

At 1230 the morning jeep arrived with a fresh can of gasoline and that crisis was over. We found much to our chagrin that the generator had been leaking gas all night and that if we had had a flashlight we could have fixed it and operated continuously. "For want of a nail the horse was lost."

At this time we crossed all fingers and tuned to 15 meters to find out whether a 40 meter dipole fed with RG58AU coax would load and get out at all. We were particularly dubious since the wire was stretched from NE to SW putting Europe directly off the end. Much to our amazement, our first CQ brought an immediate answer from OE3WWB after which a wonderful pileup developed. Ten countries in 5 zones were logged on the first page of the 21 mc log. Here it *must* be stated that the courtesy of the W, K operators during this time was phenomenal. Frequently, S9 + W stations alerted us to S4-5 European stations buried under the pile and then stood by while we worked the Europeans before making their own QSOs with us. When we called QRZ Europeans only not a W-K was to be heard. Many familiar DX signals were heard including F8RU of the IARC, DJ6QT, GW3NWV, and of course CX2CO.

It soon became obvious that 15 meters was to be our bread and butter band as we began to fill the standard contest log sheets at the rate of 3 per hour (120 contacts) at the height of activity. Our only disappointment with the band was poor propagation to South America. Only 3 YV's and 1 HK were logged as compared to 48 D-DL's and 25J G's. The antenna must have had some unusual lobes.

The contest to this point had been exhilarating though sleepless, the only objections being the rather monotonous diet of bread and cheese which we had obtained on our last minute dash up the mountain. While fresh op G3SBP, who had returned on the morning jeep, busily



Looking toward the British Virgin Islands from the bow of the Empress of Tortola. The highest peak was the location of VP2VD during the DX contest, October 23-24.

ogged in 15 meter contacts a makeshift 10 meter dipole was constructed out of bits and pieces and hung just outside the shack. Due to the shortness of the feedline the 28 mc antenna was so low that members of the party had to stoop to walk under it. However, at 1345 we loaded it up and results were superb, proving again that if you can't afford a good antenna buy a mountain top QTH. The first forty 28 mc QSOs required exactly 20 minutes as we developed a vertiable pipeline to W8 land. Sixty-two W8's were worked on this band compared to only 39 W2's and 29 W4's. VE3LZ was worked to be the first station to QSO us on all 5 bands. Unfortunately the skip was short and although we had high hopes for 6 land contacts on 28 mc we made no QSO's with the Californians. One KS6 slipped thru on very long skip.

Just before noon K4CAH and K4IIF hitched a ride to town on a passing land rover leaving G3SBP alone on the rig for a 3 hour period. A cold shower, a delicious lunch sans cheese, and a 30 minute nap really filled the bill before heading back up the mountain fortified with bed spreads and cushions to make the shack more livable. The afternoon climb was courtesy of Row Roy, VP2VA, in the hotel land rover. On arrival Dave was found busily logging in QSO's while the generator coughed and sputtered, but ran on. Loss of the generator was a continual worry but despite dire predictions to the contrary it continued to function until the operation was concluded. During the afternoon a steady pace was maintained on 15 meters until about 2140 when contacts became thin and we shifted back to 20. The QSO rate on 20 was satisfactory but it was obvious that absence of the beam was hurting us. Despite the 5/9 reports being sent to us we were too easily QRM'ed by adjacent splatter in the 14110 kc area.

The 14 mc operation continued until past 0000 GMT but the nice opening to Europe of the previous day was not repeated. Most all of the contacts were with the states except for a sprinkling of VE, YV, and central Americans. By 0100 the pickings had become so slim that we returned to 40 meters. At this juncture we hit the worst doldrums of the contest as only contacts could be made in 30 minutes. These were all W2's except for Foy W4RLS, who struggled through giving us a 3/3/40. Thanks ole buddy, we were needing them about then.

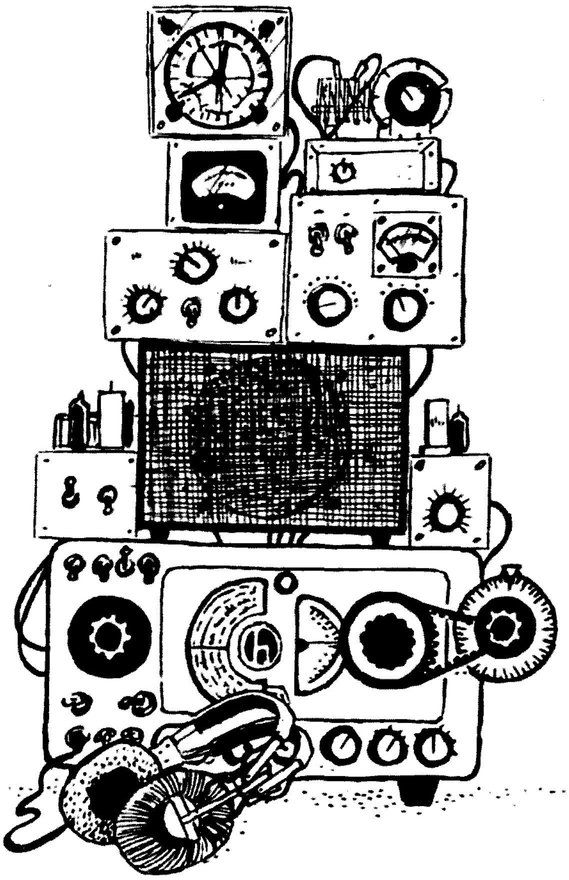
At 0200 we gave 80 meters another whirl and worked DJ1JW who was 5/9++, but was the only European heard. Would like to get a look at his skywire. The 3.8 mc band sounded real good and a lot of stations were calling CQ contest but after a return of only 6 QSO's in 40 minutes we again QSY'ed to 20. However, we could only make 12 contacts in the succeeding 2 hours on 20. At this point K4IIF and K4CAH, who had been either operating, logging, or working on the antennas for 42 consecutive hours minus the 30 minute nap at lunch, collapsed in a dead stupor and slept for over 5 hours. Dave carried on during the night but the bands were extremely erratic and did not pick up again until 1040 GMT when DX stations again began to roll through on 14 mc. A good opening to Europe was experienced including 3 consecutive OH3's at 1122-26. A few W4's were worked around 1145 and then we QSY'ed to 15 meters.

Conditions on 21 mc the morning of the 24th were quite good and many additional European stations were logged. However, the contact speed was a little slower as so many had been worked the first day. A short 10 meter break was taken from 1250 to 1255 to work two ZS, a ZD8, and a KV4, and then we retuned again to 15 meters. By 1300 more W-K's were being worked than Europeans, but DL's, G's, and SM's continued to mix it up and OHØNC was worked at 1359 for an unexpected multiplier. By 1420 we seemed to be in less demand on 15 meters. Whether this was propagation or not we didn't know, but we QSY'ed to 10 meters and resumed our pipeline operation to the states, making 56 contacts in 40 mins. before taking up the 21 mc battle again at 1500 to fill 4 more log sheets.

At 1800 we QSY'ed back to 28 mc for the last go round, having learned that the last possible ride down the mountain would be at 2000 GMT, a heart-breaking 4 hours before the contest was due to end. However, the last 2 hours were used to good advantage as 5 and ½ more log sheets were filled with 10 meter QSOs at a rate of about 110 per hour. At 1951 it was up to K4IIF to make the last contacts, K4JEY and then VE3FYF, before saying the hardest 73 ever to a still crackling band. By 2000 all antennas were down, loaded on the land rover, and the last trip down the mountain had begun.

The VP2VA group would like to thank the staff at the Treasure Isle Hotel, particularly J. R. Roy VP2VA, for cooperation far beyond the call of duty; and the personnel of Cable and Wireless Ltd., particularly Mr. John Horne and Tony, for their help in allowing us to use the facilities under construction at the Challwell Tropospheric Scatter Station. May we be in position to help you some day.

. . . K4IIF



Illustrated by Wayne Pierce K3SUK

Un-modifying the S-38

David Bartley WA5MCU
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San Antonio, Texas 78201

One disadvantage to subscribing to 73 magazine seems to be the fact that once a month, every month, one is faced with an overpowering urge to BUILD something.

Usually, when my copy arrives in the mail, I carefully read the editorial, while trying to overcome the urge to drool over all the construction articles. Unfortunately, this seldom works, and I soon find myself going through the catalogs with a pencil in one hand and an order blank in the other, attempting to determine the cheapest project in the book. Once this is found, I eagerly go to work, happy to be working on something, whether I need the finished project or not.

It would appear that I am not the only ham with this unusual addiction, for 73 seems to be flourishing, with better articles in each new issue. However, there comes a time when all those projects pile up.

This happened to me when I finally decided to get a better receiver. A deal was quickly made with the local dealer whereby he would give me a nice, shiny HQ-110 in trade for the last of my savings and my dilapidated S-38. Unfortunately for Hallicrafters, I had ruined their little SWL-type receiver while I served my time as an SWL, and so I had to modify it for acceptable use as a ham. Enter 73, lots of parts, and a few headaches.

It appeared that I would have to put the old receiver back into something resembling its original condition, or I could never trade it in. This was a crisis. I turned to 73. Unfortunately, 73 is full of modifications, but practically devoid of UN-modifications.

It finally occurred to me to take the instructions I had used to modify the receiver and simply apply them in reverse. Armed with several issues of 73, the Handbook, two equipment manuals and an unsoldering iron, I set to work.

First, I disconnected the external Q-multiplier and set it aside. Then I disconnected the external speaker, and hooked the built-in one back up. The next thing to come out was an extra *if* stage I had added outboard. Then I removed my BFO, and replaced the gimmick in the *if* for use as a BFO. The next step was the replacement of all my 6 volt tubes with the original AC/DC types, the removal of the power transformer, and the re-installation of the shock hazard. The OA2 quit glowing when the original low B+ was produced, so I took it out, too.

About this time, the chassis was getting to be almost uncluttered. It was a simple job to replace the rf gain pot with the old standby switch, although that slide switch looked rather out-of-place in a round hole. Next to be pulled was the CW noise limiter, and this really presented a problem. The clipping level pot had gone in a hole that wasn't originally on the front panel. How was I going to fill in the hole? With typical ham ingenuity (sneakyness), I took a big bolt and a couple of washers, and put a knob on it. It filled the space beautifully, but everyone wanted to know why the knob wouldn't turn! This was solved by filing a groove in the bolt for the knob's set screw to ride in. Now the knob turns freely on the bolt, doesn't fall off, and doesn't cause any embarrassing questions.

With this problem solved, I was almost through with the project. Quickly I removed the external phone jack and rewired its connections to tip jacks on the rear panel. Then I removed my vernier dial mechanism from the bandspread tuning shaft, and discon-

nected my RME preselector at the antenna terminals. A quick alignment job finished it up.

On the way to the radio shop to get my new receiver, I suddenly remembered the Rate-of-Change ANL sub-chassis I had installed. I quickly drove into a side street, stopped, pulled the receiver out of the cabinet and pulled out the noise limiter module. I looked everything over again, and saw that I had left my simple fixed squelch circuit in to cut down noise. That was easy to take out as it consisted of only two resistors. Another look and I noticed I still had a 1N34 as a detector, although I had replaced the 6SL7/1N34 of amp/BFO/detector with the original 12SQ7. Quickly I removed the diode and ran the wire over to the 12SQ7 socket. Then I hurriedly put the receiver back in its cabinet before I found something else to unmodify.

Finally the moment of decision was over—the dealer had reluctantly accepted my butchered trade-in, and I was the proud possessor of a new HQ-110.

On the way home, I merrily whistled a tune, and began thinking. I still had that outboard Q-multiplier. Why not put it on the 110? And that CW noise limiter would also be useful. And the phones jack would be much more convenient on the front panel. . . .

The following day, my next issue of 73 arrived.

Can anyone give me any advice on UNodifying the HQ-110? I just saw a real nice B transceiver, and . . .

. . . WA5MCU

James Ashe W2DXH
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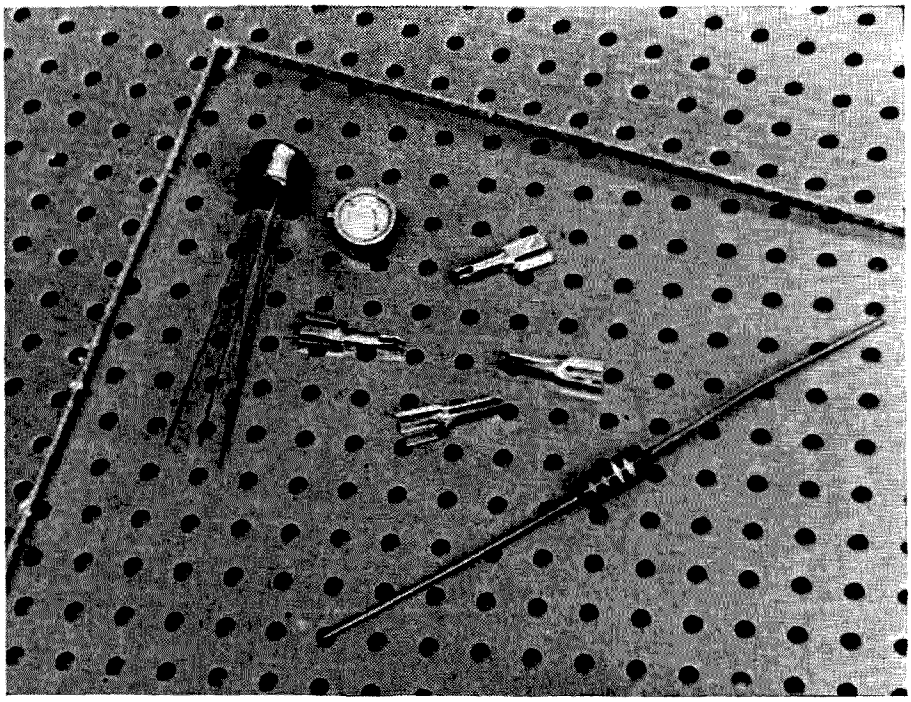
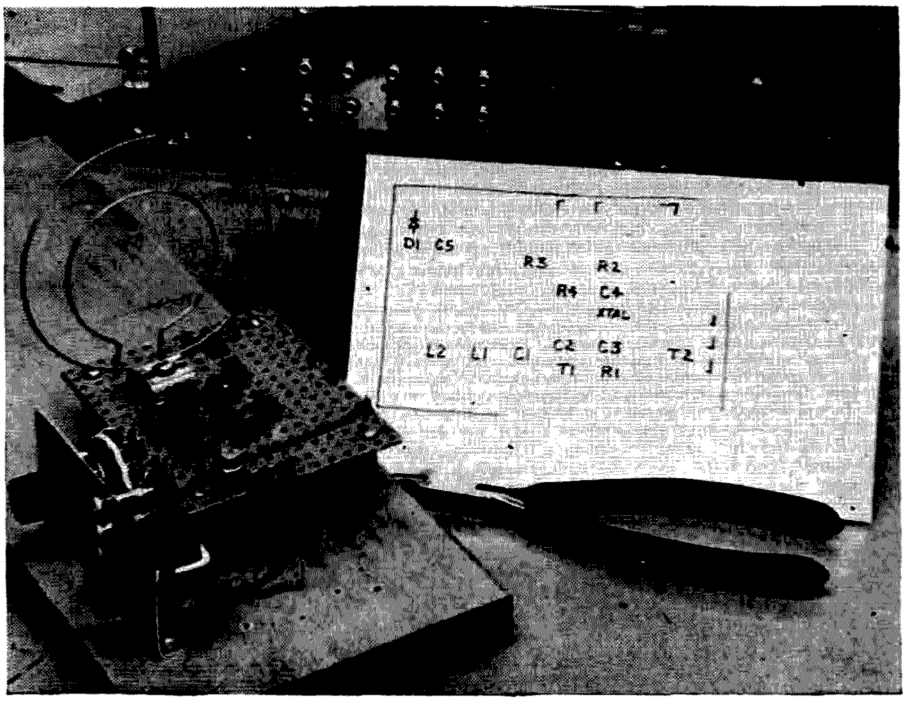


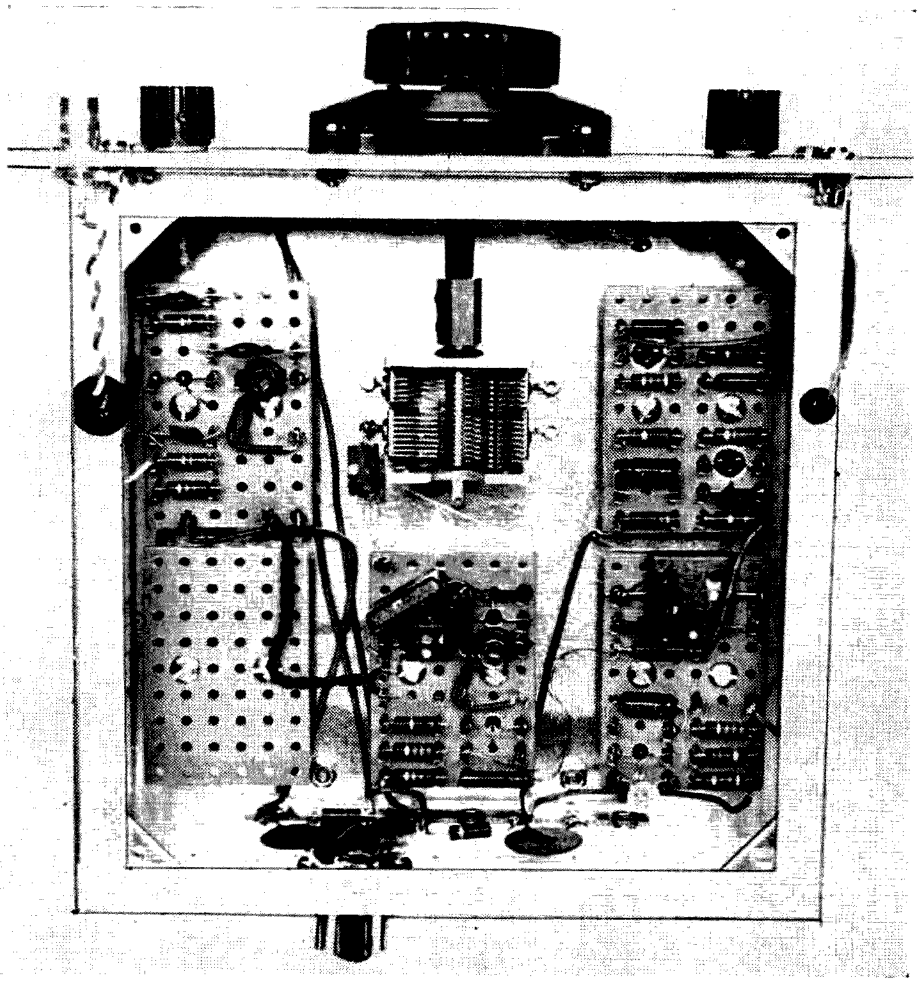
Vector Vector

Here is a way to make electronic circuits and boards that really look good. It is ideally suited to small-signal solid state circuitry and requires no special tools or chemicals. Once wired up, sections can be changed or rewired if necessary.

This style of construction uses a special punched board and clips supplied by the Vector Electronic Co., Glendale, California. Allied and Lafayette are two well-known dealers carrying Vector products.



A small layout chart and the board built from it.



A simple transistor receiver built from Vector board modules. Each module has one of the basic circuit functions on it. The modular construction makes it easy to make changes when desired and also provides needed circuit isolation.

Materials

There are two basic families of Vector board and clips. This article describes the larger variety. The board used is available in phenolic, epoxy-paper, and epoxy-glass materials, in 1/16" and 3/32" thickness with .062 and .093 inch holes in several different patterns. Sheet sizes range up to 19 x 35 inches.

For most work, 3/32" board is preferred because of its greater stiffness. I have found the ordinary phenolic board adequate for general usage. It is punched in Vector's pattern A, with .093 inch holes on .265 inch centers across and along the board. For greatest economy, the board is purchased in large pieces, such as Vector's #64AA32, 8.5 x 17 inches.

Two similar mounting clips go well with this board. Of the various types listed in Vector's catalog, the best seem to be their #T9.4 and and #T9.4A lugs. The T9.4 has a slot with teeth; the T9.4A gets along without the teeth but is otherwise similar. I prefer the T9.4A lugs because components are easily changed.

The clips are made of brass with a tin finish. They are rather springy, but bendable. A single slot at the bottom takes up to three ends of #22 wire, and two slots at the top take component leads. In general, the clips are not reusable.

If these clips are mounted in a 3/32" board, they will project about ¼" from the component side, and slightly less from the wiring side. The minimum clearance required to avoid shorts is an eighth inch or more depending on component sizes, distance between mounting centers, possible shock and vibration, etc.

Layout

Small circuits are easily built without going into the detailed procedure described below. This is the Gung Ho Class One process, suited to making computers and such. Lift from it what you want! As you become accustomed to it, you will find additional ways to avold confusion and mistakes.

One side of the board is arbitrarily labeled 'components'. Imagine or mark a line on one long edge; when you want to look at the other side of the board, turn it over that mark as over a hinge. Then the top goes to the bottom, but left-to-right relations remain the same.

The layout must be planned before starting construction. Each component is labeled, R1,

C5, D15, etc.; parts near each other in the circuit being given numbers near each other. Then these part numbers are written on a chart as the parts will be arranged on the board, with due allowance for large capacitors or other components. This will be hard to do, first time. Each diode site is marked as to which way the diode points, resistors are situated with either left or right hand ends going to supply voltages, and the natural function of the circuit proceeds from left to right. After you have built a few boards, all this and lots more becomes habit. Start small.

Board preparation

When the planning is done, you're ready to start building. First you take your board . . .

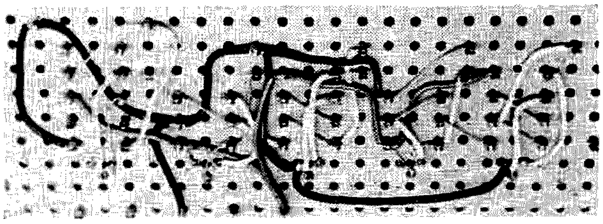
The hard plastic materials tend to be brittle. The fiberglasses are tough, but they will tear. You must cut or file, but not shear, to get the shape you want. A bandsaw is a very good tool if the correct blade is mounted on it. With care, patience, and the good word from an old machinist you can use a bench mounted saber saw. Not recommended for beginners. If cutting with a hacksaw, the work must be supported near the cut or it will bind and perhaps break.

Cutting lines are marked by scribing along a straightedge. For a good edge the cut should be off center because the blade will take out about one sixteenth inch. The cut can be made most accurately if the scribed guideline indicates its edge. Try to cut from stock so as to leave the best piece for future supply.

Rough edges left after cutting are best removed with a file. Mount the file in a vise and move the work—touch up the corners too.

Clip installation

After the board is prepared, the clips go in. They must be installed one at a time, and it's a little hard to do. With a pair of long-nose



The back of a Vector board project. Much of the wiring is done with bare wire since it's easier to use. Longer runs, or cross-overs, must be done with insulated wire to prevent shorts.

pliers, grasp the large end of the clip, place the small end in the hole, and push it in. If the clip isn't square to the board, it won't go. The number required is about two per component, so you will shortly master the trick.

Because the slots are off center, the job looks best if all the clips face in one direction. This makes imposing arrays. Don't be afraid to lay out different parts of a large board in different ways!

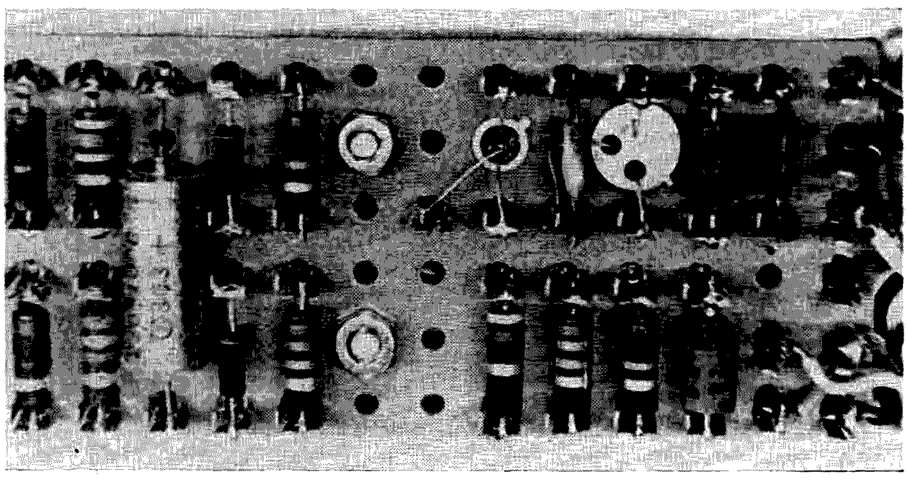
When you turn the board over, it will look like Kipling's jungle. If you did your layout as described, remember that left-right relations are the same, top-down on the layout has become bottom-up on the board, and left-hand terminals take supply leads. The picture will clear up rapidly.

Wiring

All wiring is done with #22 solid hookup wire. For simple boards and connections between adjacent clips bare wire is easiest; for longer runs Teflon spaghetti is best, but I can afford only thermoplastic insulation.

I have a nice-sounding system used as a guide in wiring up large circuits with least confusion: It goes like this:

1. Chassis-ground wiring, white insulation.
2. Positive supply insulation, orange and red.
3. Negative supply wiring, gray and black.
4. Emitter, base and collector wiring, yel-



Closeup of a small board showing one way to mount transistors.

low, green, blue respectively.
5. Signal wiring, violet.
6. Finish up where required.

Those are the rules. I make a reasonable effort, no more, to follow them. After all, the goal is a circuit, not an illustration.

Component mounting

Components are mounted by pressing down into the clips, which may require a little bending to hold well. For test purposes there is no need to solder the components in, but you should be careful that they are tightly held. Diode and electrolytic capacitor sites should be marked to indicate direction, with something a little more permanent than ink.

Transistors may be mounted several ways. The plastic board has no heat dissipating properties at all so you must use a sink for anything that runs hot. If you are working with small signal transistors, a nice way is to bore a hole just large enough to take the leads, place a clip on each side, and run the emitter and collector leads to these clips. These hold it in place. A slightly larger hole will take a socket, which may be held in place with some epoxy or a super glue. Celluloid cement will be too weak.

If you're brave, the circuit is trustworthy, and the transistor is sure to be good, there's absolutely nothing better than wiring it in. You can rely on solder connections to stay made. It's a good feeling.

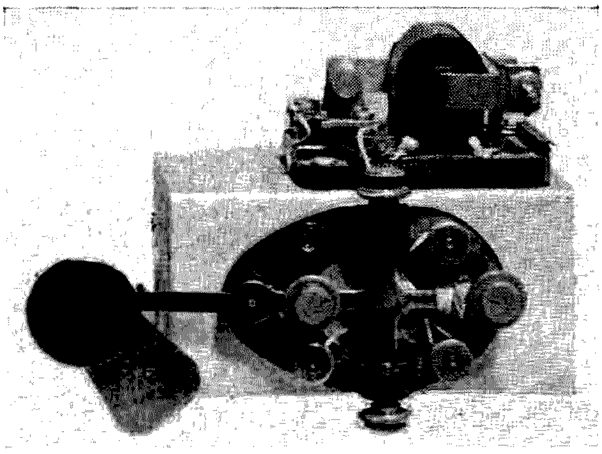
When everything is working properly, the clips may be soldered. Easy on the solder, and work fast. The very short leads can carry lots of heat into resistors and capacitors as well as transistors and diodes.

Soldering guns are far too clumsy for this work. The best tool is a small iron of modern design, operated from a Variac or series resistance to reduce its temperature to no hotter than the job requires. An isolation transformer might be good insurance, because some irons are leaky enough to light up a neon lamp! Try it and see.

Feedback

With their low input impedances, transistors aren't much troubled with feedback problems. But low impedances tapped into tank circuits become high impedances! And this type of construction isn't remarkably low on circuit capacitance, although careful layout and a little distance between sensitive points will generally be adequate. The extreme approach is to break up the overall circuit into subcircuits, each on its own board, and put shielding between where required.

. . . W2DXH

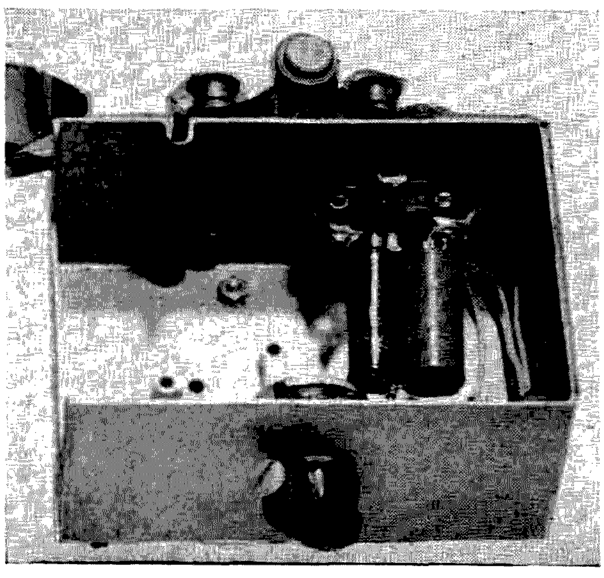


Side view of the Cathkey. Construction is completely non-critical.

Cathkey

A Cathode Powered Cathode Keyer

Henry Meiseles K2UOC
1523 45th Street
Brooklyn, N.Y. 11219



Interior of the Cathkey.

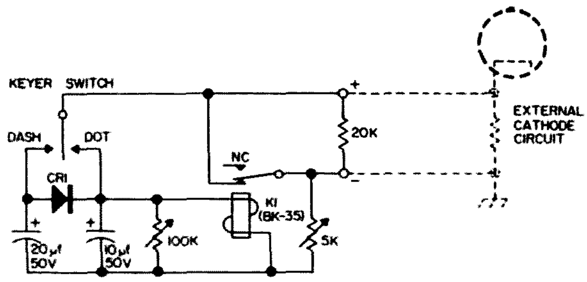


Fig. 1. Schematic of the Cathkey.

The Cathkey is an adaptation of the Corkey tubeless electronic keyer[1]. The essential feature of the circuit is this: Cathkey derives all its operating power from the keyed source itself. Just plug it into the key jack and that's it. No reduction of transmitted power occurs since the keyer draws power only during the key up intervals.

The circuit functions in the following manner:

1. Assume the keyer switch is placed in the dot position. This places the 10 μf capacitor, 100 K potentiometer and relay K1 across the external cathode circuit through the 5 K current limiting pot. In this dot position, the 20 μf capacitor is isolated by diode switch CR1; placing the keyer switch in the dash position places the 20 μf capacitor in parallel with the aforementioned components increasing the RC time constant for the dash cycle.

2. K1 becomes energized, forming a ground return path for the external cathode circuit through its contacts. This keys the transmitter and simultaneously shorts the cathode potential which supplies voltage to the keyer circuit.

3. The stored energy in the capacitors maintains K1 in its energized state for the duration of the time constant which is determined by the fixed values of the capacitors, K1, and the variable adjustments of the 100 K speed control potentiometer and relay contact spacings.

Upon capacitor discharge, K1 de-energizes and opens the cathode ground path. If the keyer paddle is held in a contact position the cycle of steps will be repeated. The circuit is of the self completing type.

It was found that relatively high values of the capacitors tended to shape the keyed waveform. However, the resulting CW note was not unpleasant to listen to.

. . . K2U0C

1. "Tubeless Minikey," QST, November 1961.
"Corkey-A Tubeless Automatic Keyer," QST Hints and Kinks, 1954.

Hank Cross W1OOP
111 Birds Hill Avenue
Needham, Mass.

All Solid State

While some applications are particularly suited to transistors (low voltage-high current power supplies, for instance), the application of power transistors to a regulated 150 volt plate supply for vacuum tubes, described here, is neither simple nor inexpensive. The semiconductors for an all-solid-state version cost about $20, but by employing a VR150 or OA2 for the 150 volt reference it is possible to save about $6. A VR breaking down at 85 to 110 volts can be substituted for the other protective (zener) diode at a further saving. This worked fine until I cracked the glass on the one that I was using and blew another transistor. I decided that it was worth a few extra dollars not to have that happen again.

The original circuit was carefully tested in the laboratory using the arrangement in Fig. 1. So far as we could find out, everything was excellent, except that the limited breakdown voltage of the transistor used made for some loss of regulation under abnormally high line voltages.

Fig. 2 shows the final version of the regulator. The differences are not all obvious, but the pitfalls that I encountered at $4.50/pitfall (it wasn't just the money, my morale also got very low) explain the added parts.

1. During tests, a cliplead shorted. Before the next time, we inserted the fuse and 15 ohm resistor.

2. When the regulator is feeding a capacitive load, the charging transient is about as bad as a shorted load, and when the OA2 fired abruptly in the circuit of **Fig. 1B**, there was high voltage across the pass transistor at the same time there was reverse voltage on the base. (For why this is bad, see the Motorola Power Transistor Handbook under "second breakdown".) The 15 ohm resistor and the 1N334ORA protective diode handle this. An OC2 may not be a good enough protective shunt, in that its internal resistance is about 100 ohms, compared to the 15 ohms in series with the breakdown characteristic of the transistor (negative resistance for some types, about

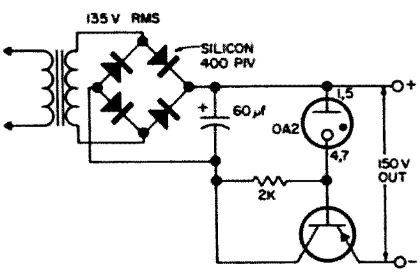


Fig. 1A. Simple circuit. Blows transistors.

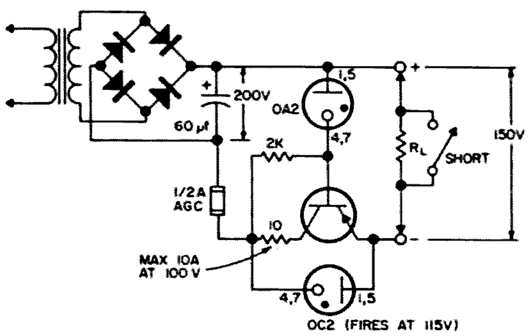


Fig. 1B. Over-current and over-voltage protection.

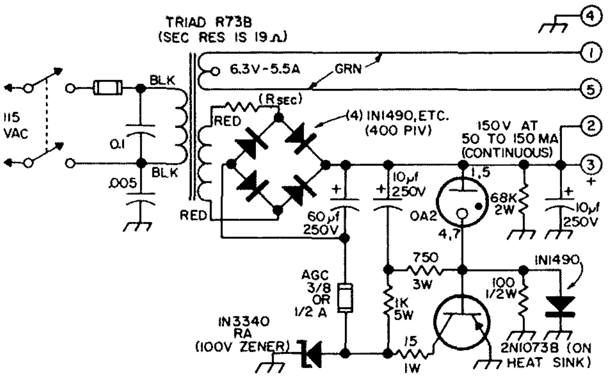


Fig. 2. Complete power supply. Heat sink is Astrodynamics 2505 or Delco 7270725, or Astro 2504 mounted against chassis by a sheet of .005 Teflon or Mylar.

Table I

Current in ma	Volts	Volts rms ripple
10	147	.014
105	147	.060
200	146	.160
450	135	1.00

zero ohms for the 2N1073 series.) A lower power rating might be okay for the zener, but would only save about two dollars. I played it safe.

In a further effort to reduce the turn on current surge, the 10 µf capacitor in the lead to the VR tube and transistor base was installed. It also reduces ripple.

3. When a standard alloy type having high breakdown voltage was used for the pass transistor, it blew immediately, from collector to base breakdown. The DAP structure of the 2N1073B has low reverse breakdown between base and emitter; a silicon diode across this junction was added to protect types with higher BVebo. A 100 ohm resistor was also inserted, to insure thermal stability in the event of a defective or out-of-socket OA2.

After this last change, the circuit was that of Fig. 2. The Triad R73B transformer is ideal for a silicon bridge rectifier; its 19 ohm series resistance being high enough to limit the surge current to a safe value for most common receiver type silicon diodes. The 5.5 amp filament winding is adequate for several converters or a receiver plus converter. The DC rating is 200 ma total, substantial for so small a transformer. The last transistor inserted has survived for eighteen months, about a thousand hours and two hundred cold starts, so I think the problems are licked. If you want to try to make one like it, go ahead, but any modifications are at your personal peril; all I'm sure of is that there are possibilities of disaster in the simplest circuit.

. . . WIOOP

Martin Barrack WA2ZKR
2180 Holland Avenue
Bronx, New York 10462

QSL Here is Homebrew, OM

Every year, in thousands of new hamshacks, this scene ensues. The Novice sends away to all the QSL printers that advertise in 73, QST, the Callbook and Popular Electronics. Then, amid samples of stock, print styles, cartoons, illustrations and doo-dads, the new ham "sends away" for the card that expresses his personality . . . 96 point callsign, as in the WA6XXX card, superimposed on the schematic-diagram background, as in the WA5XXX card, with overside fill-in data as in the ZD10AA card.

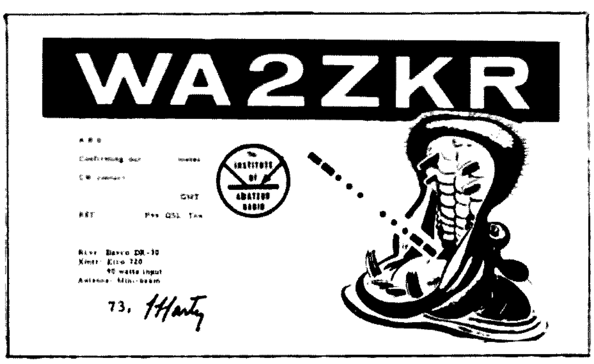
The January '62 issue of 73 had a good article on making QSL's for club members. The idea was that all the members could chip in to pay for an artist's design which would then go on all of their cards. This approach is fine if you don't mind carbon copy cards and belong to a club. If not, it's not.

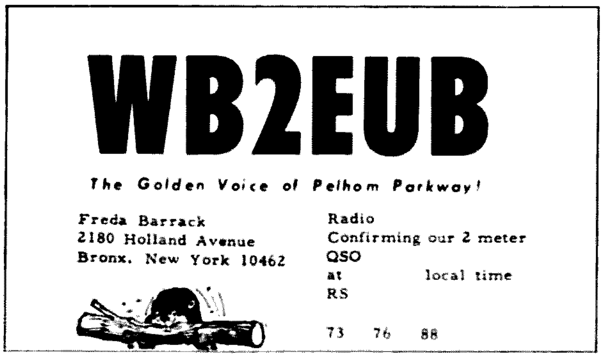
Many DX QSO's take less than a minute; the really rare ones run about 20 seconds. Your personality is your QSL. And when you're angling for a rare card or overseas friendships you won't cut ice with a carbon copy card. An original, imaginative card will stay on his wall and get you his card in reply. In general, homebrew cards cost less than store-bought ones, too.

The cheapest way to roll your own is with paste-ups and postcards. This actually gets you the stock free, because the 4¢ apiece you pay for them is only postage. Get some paste, oak tag or white cardboard, scissors, a typewriter, some typing paper and a few hundred postcards. About that typewriter, beg or borrow the best you can find. If a friend works in an office with an IBM Executive or other plush electric, ask her to peck out a few words for you on lunch break. Try for the smallest, plainest type you can get. But you type out your name, exact QTH and all fill-in data exactly as you want it to appear on the card first. Use a ruler to mark off on the oak tag or white cardboard the exact dimensions of a postcard. Then draw in very light blue (which won't reproduce) or VERY light black (erase before printing) pencil a border about ⅛ inch inside the postcard dimensions. Your working area is inside the border. Type on paper your fill-in data, name and QTH. Look around in magazines for a small cartoon illustration that would be amusing and to the point of a QSL. Cut out the fill-in data and the cartoon. Now the callsign . . . you can stencil it in heavy black pencil or india ink, you can cut it out, letter by letter (all same size and style) from magazine type, or for a little money your printer will set it in your chosen size and style.

Position the cut-outs on the oak tag as you want them to appear. Make sure spacing is even and everything is level. When you're ready, paste each item to the oak tag.

To decide how many postcards to buy, remember that the printer has to take time and expense in preparing the negative, plate and press. The more cards you make the smaller your printing cost per card. However, if you're a Novice you may prefer to print comparatively few. If I were a Novice on CW I'd print about 200 cards. An active General on the DX bands might go 500 or more. Make sure you've included everything . . . name, QTH, other station's callsign, band, date & time, RST, Pse QSL Tnx, Rcvr, Xmtr, Ant, IoAR, ARRL, etc., then cart paste-ups and postcards down to the printer.





If you live in a scenic area or tourist magnet, buy an attractive picture postcard (designed to be viewed horizontally) with at least an inch on top you can cover with your callsign. Look for the maker's name and address in small type on the back. Write to him, asking cost for so many hundred cards. When you get them, send them off to a reputable QSL printer for typesetting your callsign, name & QTH, and overside fill-in data. The professional color photo on the card would look peculiar with a homebrew typeset job.

Perhaps you or a friend has some drawing talent. Have him do up a cartoon of you at the rig. Or perhaps a humorous map, "How the U.S. looks to a Texan," showing Texas larger than Alaska and most of the East Coast. This sort of thing is effectively done gently and from the viewpoint of your own state. Any pleasant cartoon to the point of a QSL is okay.

Fill-in data, if you type your own, will vary with the operator. If you'll keep your rig as long as you expect the cards to hold out, type it in; it'll save writing. If you're a contester or DX'er be sure to duplicate fill-ins for band and mode so you can verify "two-way SSB" QSO's. Reports of CW men should use RST, SSB men use QSA, and AM'ers just RS. If you're multi-mode, use Report. Women can use PRETTY PSE QSL TNX, crossing out what doesn't apply. Religious hams can close with "73 & 76" (God bless you). You can also print in "73 76 88" and check the appropriate one.

The card may be decked out in a variety of ways. I clipped an IoAR insignia from an issue of 73. You'll find the ARRL emblem in QST, your college insignia in the catalog, your state insignia from a Chamber of Commerce. Other symbols can be typed in as a group: RACES, AREC, RCC, DXCC, ROWH, OOTC or what have you.

If you are a photography buff you may be able to get in a photograph of your house, station or even yourself. The trick is to use extremely high contrast techniques all along the line. Try contrast-process (orthochromatic) film, developed in Hunt's Graph-O-Lith developer per instructions. Print on No. 6 paper if you can get it. The reason is that this simple offset process doesn't allow for any tonal range whatever. No grays; black or white. To offset print gray tones you'd have to velox the picture using a special expensive screen which makes a photo composed of maybe 100,000 tiny dots. Money.

There are a few cautions. If you try printing negative, with while letters on black background, do it only with your callsign. If you try printing typewriter-sized letters negative the large amount of ink will block up, forming poorly shaped letters. I'd say minimum type size for negative work is about 24 point (¼ inch high).

Stay away from newspapers for copy, type or even cartoons. Reproduction quality is marginal and the paper tears easily while you're working on it. But if you really want a newspaper cartoon, use it. There are no other hidden obstacles.

Try to stick to one side printed, one color. Each extra color or side printed usually calls for an extra paste-up, negative, plate and print run. For example: for a red-and-blue card mount the material to be printed blue on one paste-up. The printer will make a plate and run the cards through the press using blue ink. Then put the material to be printed red on a different paste-up (not the back of the first one), and the printer will make a second plate and run the cards thru the press a second time. Don't try to overlap for a third color unless the printer is using transparent inks and says it's okay. Printing on the overside of the card similarly calls for a separate paste-up, plate and print run. You pay the bill.

Use offset printing. There are many printing techniques, most of them too expensive. Roto-gravure is beautiful, but I'd spend the same money on a new receiver. A QSL isn't supposed to look like a wedding invitation anyway. Only spirit or mimeo is cheaper than offset.

Shop for a printer as vigorously as for a used receiver. Prices vary. Decide what kind of stock you want (post-cards, picture-post-cards, post-card blanks, white or colored, mat or coated, etc.), whether you want the printer to set your call and QTH in type, how many print runs and cards you'll want, and bargain!

Homebrewing a QSL is as interesting as rolling your own rig, and your custom card will tarry in homes around the world as an honored guest.

. . . WA2ZKR

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The 88¢ Varactor

Use inexpensive diodes for frequency multiplying, limiting, protecting, switching, and tuning

Up until recently the variable reactance diode or varactor has been used principally by amateurs in parametric amplifiers. Because of their relatively high cost, hams have done very little experimentation with this versatile semiconductor device. Consequently, there are several worthwhile applications which remain relatively unknown. With the advent of the 88¢ varactor, a few of these uses should be considered. Although the 88¢ varactors used by the author were purchased at a Lafayette Associate Store, it is reasonable to assume that other outlets will have similar bargains as time goes on and some readily available ones are listed later.

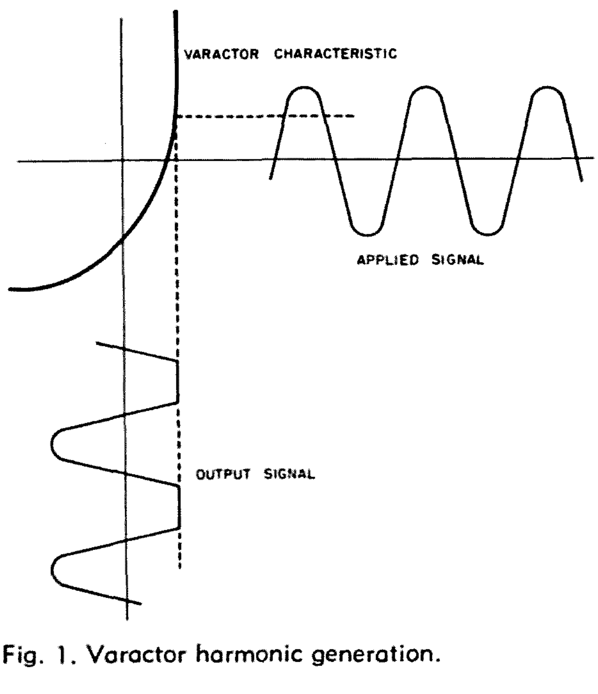


Fig. 1. Varactor harmonic generation.

Basically, the varactor is a microwave varicap characterized by a small voltage controlled capacitance and is essentially nothing more than a specially manufactured silicon diode. In fact, for many applications requiring varactors, ordinary silicon diodes behave rather well. However, at higher frequencies, a diode designed specifically for varactor service has fewer parasitic elements than the garden variety silicon rectifier and provides better results.

When the anode and the cathode of a diode

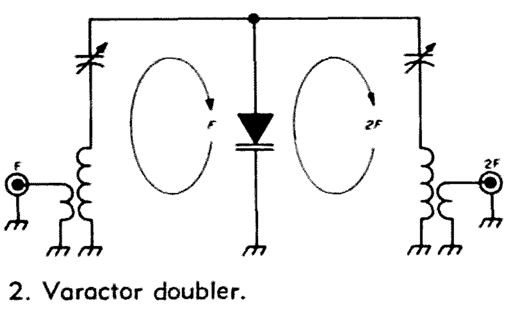
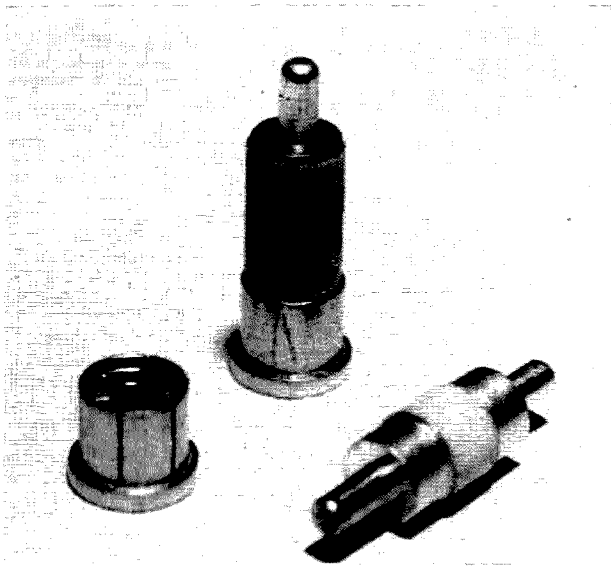


Fig. 2. Varactor doubler.

are diffused during the original manufacturing process, electrons from the cathode cross over the junction to the anode side. This exchange of electrons creates an electrostatic field across the junction with the positive charges residing in the cathode and the negative charges in the anode. If an external bias is applied to the diode such that the cathode is more positive than the anode (reverse bias), it tends to draw electrons away from the junction into the cathode region. Simultaneously, the bias potential tends to push electrons toward the junction from the anode and increases the electrostatic charge across the junction by increasing the number of negatively and positively charged silicon atoms nearby. This action is quite similar to that which occurs when a capacitor is charged, and by virtue of this mechanism, it can be seen that the diode junction acts like a capacitor. If the bias voltage is increased, the total number of ionized atoms increases, thereby increasing junction capacity; therefore, the junction exhibits a voltage variable capacitance. It is this property which is useful in harmonic generators, limiters, rf switches, attenuators, modulators, circuit tuners, and of course, parametric amplifiers.

Frequency multipliers

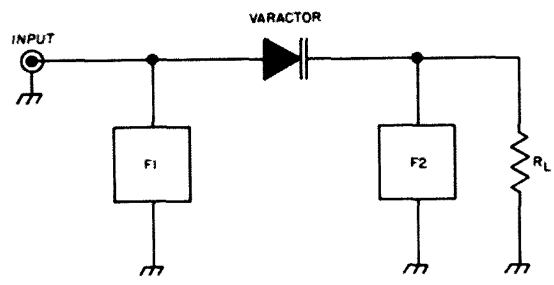
One of the most important roles of the varactor is an efficient frequency multiplier or harmonic generator. **Fig. 1** shows how the nonlinear junction capacity results in harmonic generation with these devices. When the junction capacitance of the diode is "pumped" with an incoming signal, the resultant output voltage is badly clipped and rich in harmonics. The varactor should be operated in its most nonlinear range to obtain optimum results as a harmonic generator; in this way the harmonic content of the output voltage is maximized. In most cases the optimum bias point must be determined experimentally, but in any case, some type of bias must be provided to the diode. Either fixed or automatic bias may be used for this purpose, but automatic biasing is the most convenient. This is because the leads associated with an external bias battery are susceptible to noise pickup and can be quite troublesome. Also, fixed bias must be manually adjusted. In high power varactor multipliers the use of automatic bias is necessary to prevent damage to the varactor in case of overloads.



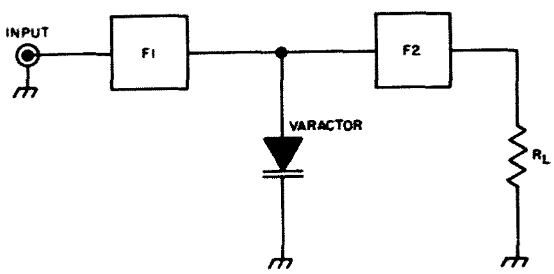
The 88¢ varactor.

The most interesting feature of varactor harmonic generators is the high efficiency obtainable in doubling, tripling and quadrupling. It is not unusual to obtain efficiencies of 50 to 90 per cent in single stage multipliers. In theory, frequency doubling may be obtained in either a shunt or series circuit arrangement as shown in **Fig. 3**. In the series circuit, the input and output tanks are tuned to the input and output frequency respectively and exhibit high impedances at these frequencies. At all other frequencies they constitute short circuits. In the shunt arrangement, the tank circuits are designed to present short-circuits to the input and output signals; at all other frequencies they represent an infinitely high impedance.

The essential differences between these two circuits is that in the series arrangement, rf currents of the first, second and all higher har-



SERIES



SHUNT

Fig. 3. Varactor doubler circuits.

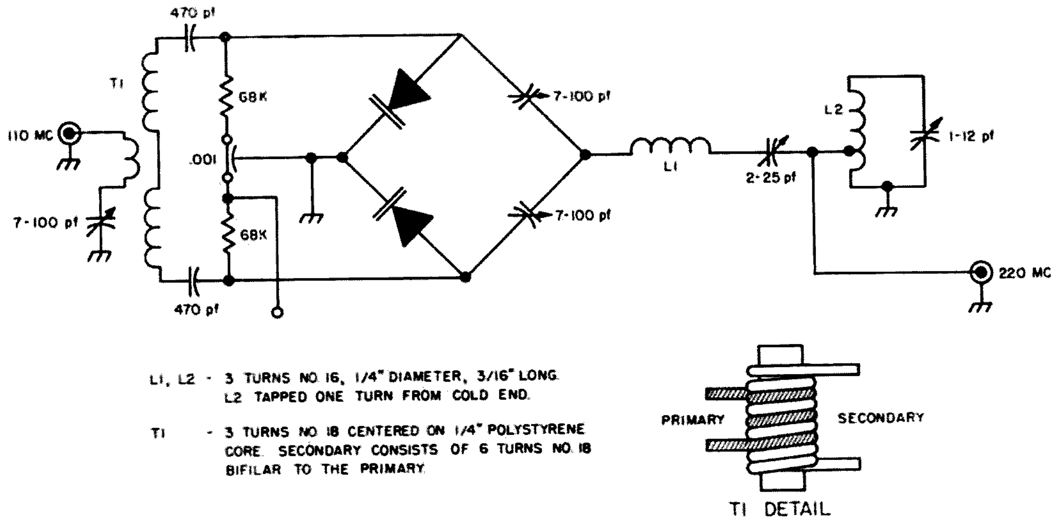


Fig. 4. Balanced varactor doubler.

monics flow through the varactor. In the shunt arrangement the tank circuits allow only the desired rf currents at the input and output frequencies to flow through the diode. This means that in the shunt circuit it is considerably easier to separate the desired and undesired frequencies because the undesired harmonics are inherently attenuated by the resonant tanks. In addition, losses encountered in the varactor are higher in the series circuit. For these reasons, the shunt multiplying circuit is the most desirable configuration. An added advantage of the shunt circuit is that the cathode of the diode is grounded; this makes physical heat sinking of the device more convenient.

An interesting variation to the single-ended varactor doubler circuit is the balanced circuit shown in **Fig. 4.** This particular configuration has several definite advantages over the single-ended doubler because it can handle twice as much power with the same type diode. In addition, the driving energy is automatically cancelled out when the bridge is balanced, thereby simplifying any filtering requirements. In this circuit the trimmer capacitors eliminate the need for matching the diode. About 70% efficiency may be obtained with spurious responses being approximately 40 db below the output signal. With this circuit it is absolutely imperative that the physical component layout preserves electrical balance.

For higher orders of multiplication the simple doubler circuits are inefficient and must be modified by the addition of a so-called "idler" circuit. In the tripler circuits depicted in **Fig. 5,** the idler circuit is represented by "F2", indicating that it is tuned to the second harmonic of the fundamental. Both series and shunt type tripler circuits are illustrated, but the advantages of the shunt arrangement as noted under frequency doublers apply equally well to higher order multipliers.

In **Fig. 5** the blocks designated by F1, F2 and F3 represent filters with zero impedance at the first, second, and third harmonics respectively; at all other frequencies they exhibit essentially infinite impedance. The operation of this circuit may be explained as follows: when the driving signal is applied to the input of the multiplier, the fundamental rf current flows only through F1 and the diode; it cannot flow through either F2 or F3 because they present infinitely high impedances at the fun-

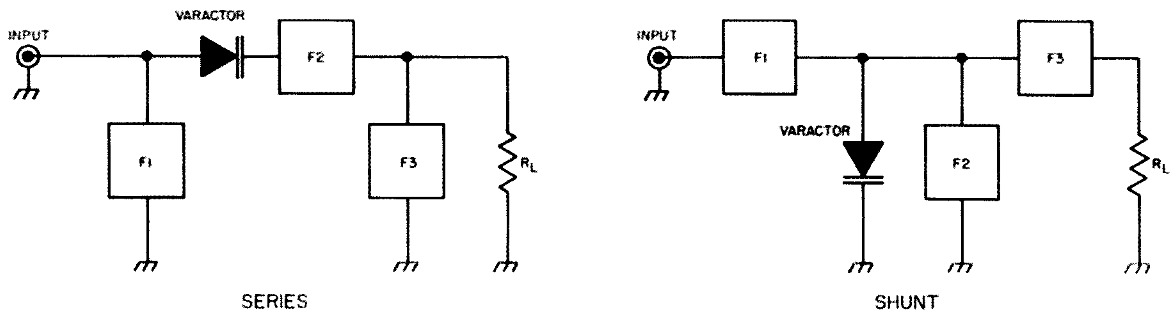


Fig. 5. Varactor tripler circuits.

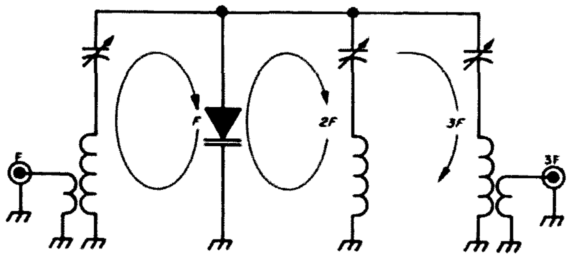


Fig. 6. Varactor tripler.

damental frequency. Because of the nonlinear characteristic of the varactor, second harmonic energy is developed across the diode. This second harmonic current circulates only through the diode and F2, because at this frequency F1 and F3 constitute high impedance. The fundamental and second harmonic currents circulate simultaneously through the diode, which operates as a mixer and produces energy at the third harmonic (i.e., F1 + F2 = F3). The third harmonic current flows through F3, the diode and the load (R_L), but not through F1 or F2 which again offer an infinitely high impedance.

A similar explanation may be given for the operation of a frequency quadrupler; the only difference between the circuits is that the output tank in the quadrupler is tuned to the fourth harmonic instead of the third. In the tripler circuit the varactor operates once as a doubler and once as a mixer; in the quadrupler it doubles twice. However, even with careful tuning, a quadrupler will have considerably more loss (and less output) than two cascaded doublers.

Theoretically, a varactor may be used for even higher orders of multiplication, but the number of idler circuits must be increased accordingly. Unfortunately, these additional tuned circuits seriously limit the bandwidth of the multiplier stage. This becomes important because as the varactor is excited by the fundamental signal, the associated capacitance change will slightly vary the resonant frequency of each of the tuned circuits. In cases where bandwidth is relatively narrow, the circuit will be detuned to the point where efficiency is seriously effected.

Limiters

The varactor limiter provides a simple method for protecting receiver input circuitry at VHF without degrading low-level signals. In strong signal areas some type of protection is required, particularly where transistor rf amplifier stages are involved. The beauty of the varactor is that it may be placed at any convenient point in the circuit with a minimum effect on circuit operation, except for signal limiting. In addition, these devices are inherently self-limiting and require no external bias to achieve limiting action.

A good high quality varactor diode exhibits a typical zero bias capacitance of about one picofarad; less than normal wiring capacity. When the input signal is less than one milliwatt, the varactor capacity is not effected, but as the input power is increased to 10 milliwatts or more, sufficient voltage is developed across the diode to increase its effective capacity. Under this condition the shunt capacity across the circuit increases the insertion loss by several tenths of a db. As the input power is further increased, varactor capacity increases, and at about the 50 milliwatt level the capacity is sufficient to shunt nearly all of the incoming signal to the ground. As the input power is increased beyond this point, the diode becomes essentially a short-circuit across the protected stage. The limiting properties of a typical diode of this type are plotted in the graph of **Fig. 8**.

There are two basic configurations of varactor limiters; the single diode limiter in **Fig. 9** and the two diode shunt-opposed limiter in **Fig. 10**. The action of the single diode limiter varies under different signal conditions.

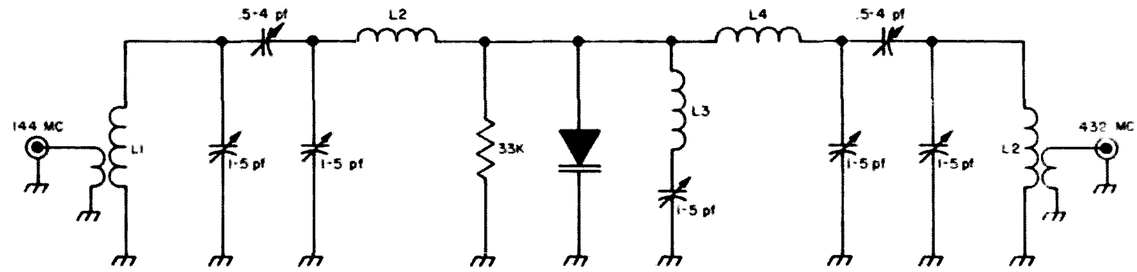


Fig. 7. Practical varactor tripler.

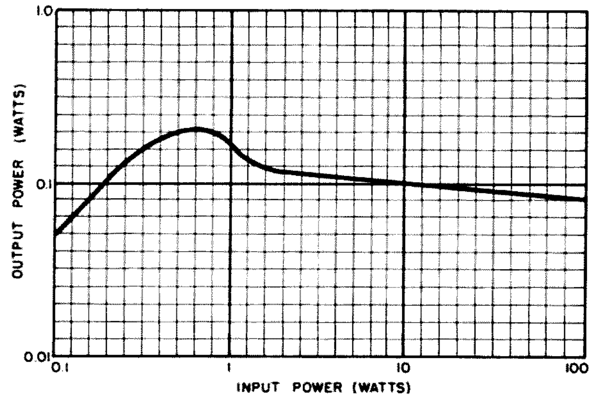


Fig. 8. Typical varactor limiting.

but the "worst case" is illustrated by the accompanying waveform shown in **Fig. 9.** A rather rigorous mathematical analysis shows that just the right phase relationship must exist for the voltage spike to occur, but even though this unfavorable phase will occur only about half the time, in many cases the spike is sufficient to burn out transistor rf stages. The fact that the voltage is **sometimes** absent offers little comfort.

The size of the spike decreases with frequency and might be tolerable when the incoming signal is not too large, but a complete analysis of the operating conditions requires some rather healthy math and the possibility of voltage spikes certainly encourages the use of the shunt-opposed limiter of **Fig. 10.**

In the shunt-opposed circuit, the first cycle begins in a manner similar to the single diode configuration, but regardless of the phase of the incoming signal, the second varactor begins to charge and limits the negative voltage excursion where the spike previously occured. The second diode will carry the current, first charging and then discharging, until the average net charge across the circuit is zero. It does not however, immediately settle down to a nice, even, periodic waveform. Although each succeeding cycle comes closer and closer to being the same, theoretically it takes an infinite number of cycles before they are precisely identical. However, for all practical purposes, they can be assumed to be the same after ten or eleven complete cycles.

The isolation of the shunt opposed pair can be improved by the use of forward bias, but there is the chance that this bias will favor the uneven disposition of rf current between the varactors. In this case the diode first charged in the forward direction will tend to carry all of the incoming signal current.

A typical application of the limiter is where the varactor is connected in shunt across the tank circuit of a transistorized rf amplifier as illustrated in **Fig. 11.** One advantage of this application is that the diode may be added to existing circuitry with a minimum of circuit retuning. This same approach is equally applicable to vacuum tube circuitry (**Fig. 12**) or, if desired, the varactor limiter may be inserted directly across the transmission line to the receiver.

Switches

The operation of the varactor diode as an rf switch is somewhat similar to that of the limiter. As a switch however, the required capacitance change is controlled by an external bias source. In normal operation, this application more nearly parallels the operation of a vacuum tube TR switch than an antenna changeover relay.

When a varactor is installed in series or in shunt in a transmission line, the rf power transmitted down the line to the diode is either reflected, absorbed, or transmitted past. Although the power in an ideal diode switch would be either entirely reflected or totally

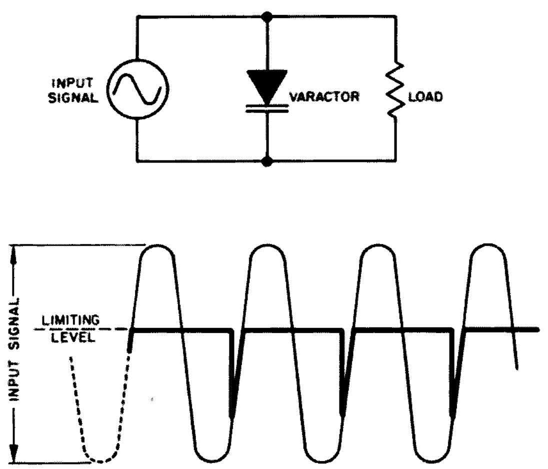


Fig. 9. Single varactor limiter.

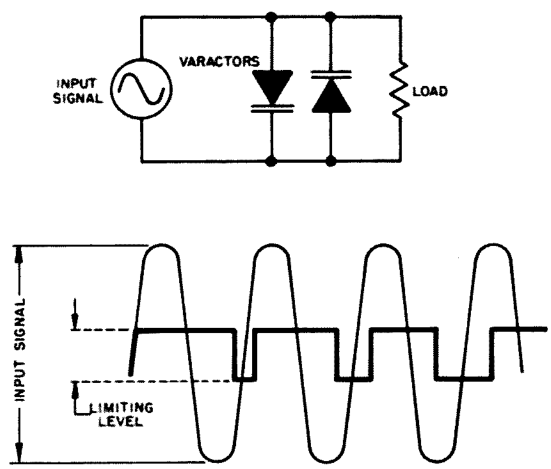


Fig. 10. Shunt-opposed varactor limiter.

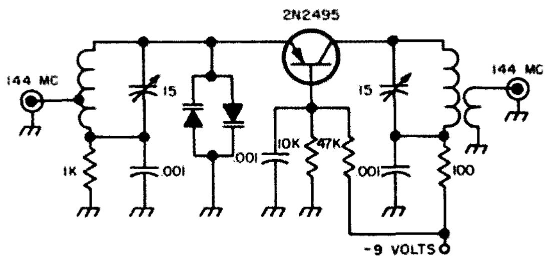


Fig. 11. Varactor protected transistor stage.

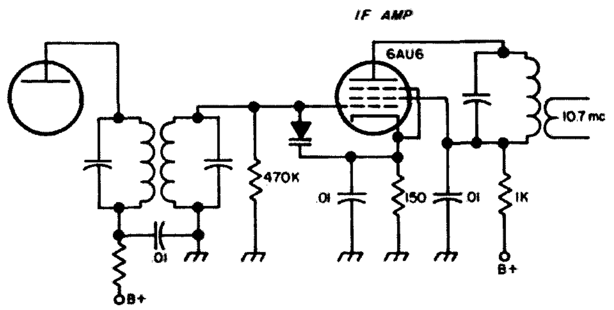


Fig. 12. Varactor FM limiter.

transmitted, a practical switch is not quite this ideal. In most cases more power is reflected than absorbed however, and with typical insertion losses of 0.3 db and isolation of 40 db or more, the diode switch is at least as satisfactory as the common solenoid operated coaxial relay. At frequencies up to about 1000 mc the series switch provides slightly greater isolation than the shunt arrangement when used in 50 ohm coaxial lines.

When a reverse biased diode is installed in series with the center conductor of a coaxial line (**Fig. 13**), the small junction capacity (on the order of 0.5 pf) presents a high impedance in series with the line. At 3.5 mc for example, 0.5 pf represents nearly 100,000 ohms; this appears as an open-circuit to the 50 ohm line and most of the r-f power is reflected. On the other hand, when the diode is forward biased, the junction capacitance increases and results in a negligible impedance in series with the line. The overall effect in the forward-biased condition is an rf impedance that presents a low-loss, near match to the transmission line and allows the rf power to pass.

In the shunt configuration, diode switching is essentially the converse. If a reverse bias is impressed across the diode, the extremely small junction capacity placed across the transmission line results in very little added loss, typically less than 0.5 db. However, if the varactor is forward biased to maximum capacity, the large shunting capacity of the diode effectively shorts the line and reflects the r-f power.

There are several switching schemes in which these characteristics may be used to control the transmission line during receive and transmit cycles. Perhaps the simplest of these is the single diode arrangements shown in **Fig. 14**. This circuit takes two basic forms, depending on whether a shunt or series diode is used. In the shunt arrangement, the varactor is biased to maximum capacity during the transmit cycle. With the line effectively shorted, the transmitter sees an infinite impedance one-quarter wavelength away. In fact, to the transmitter it appears that the line to the receiver doesn't even exist. When receiving, the diode is reverse-biased and signals from the antenna proceed down the line to the receiver undisturbed.

If a series diode is used, the switch is located one-half wavelangth away as shown in **Fig. 14B**. During the transmit cycle in this case, the diode is reverse biased and presents a high impedance across the line. This effective "open" line is reflected to the transmitter one-half wavelength away and again it appears that the receiver line does not exist.

The major disadvantage of these simple single diode switches is that they may be used only over a very narrow band of frequencies. This is perfectly satisfactory for spot frequency operation such as occurs on our 432 and 1296 bands, but on the lower frequencies a more broadband device is required. Another disadvantage of this switch is that

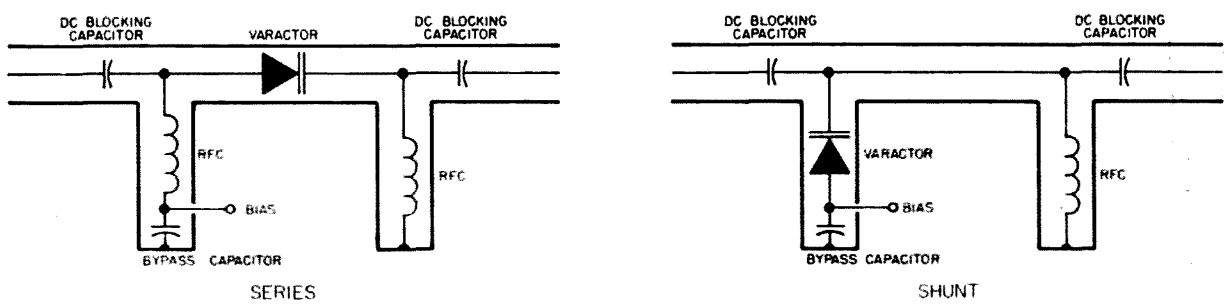


Fig. 13. Coaxial Varactor rf switches.

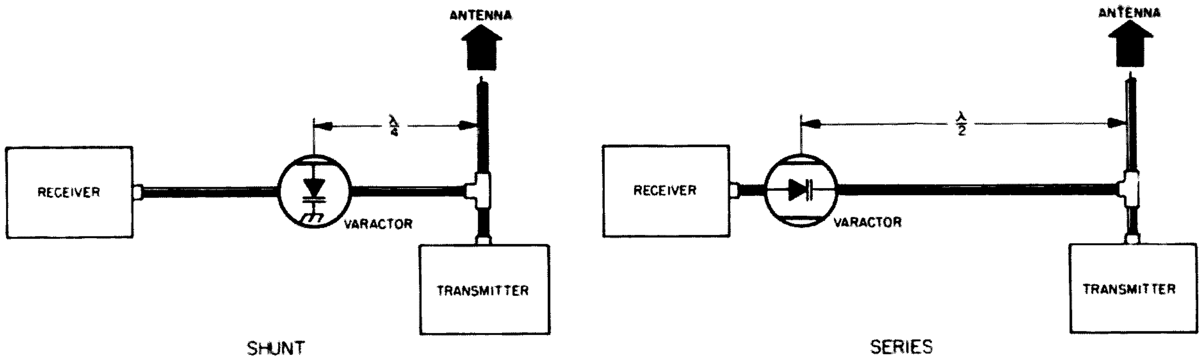


Fig. 14. Single varactor transmit-receive switches.

slight losses occur to the received signal because the output tank of the transmitter is not isolated from the line.

The transmission line switch shown in **Fig. 15** overcomes these disadvantages by the simple expedient of adding another diode. This two diode circuit is not at all frequency conscious and may be used over extremely wide bandwidths. In this circuit both the receiver and transmitter portions of the transmission line are diode controlled. When transmitting, diode #1 is forward biased and diode #2 is reverse biased. Under these conditions, the transmitter power is passed by diode #1, but the high impedance presented by diode #2 effectively opens the line to the receiver. In the receive mode, the opposite is true; the transmitter is isolated from the line and the antenna signal passes into the receiver with little loss.

One of the most important considerations in diode switches is the amount of rf power they can safely handle. Actually, there are two separate and distinct ratings that are of interest: peak power and average power. The peak inverse voltage (PIV) rating of the diode determines the maximum peak power that the diode can control. The average power which

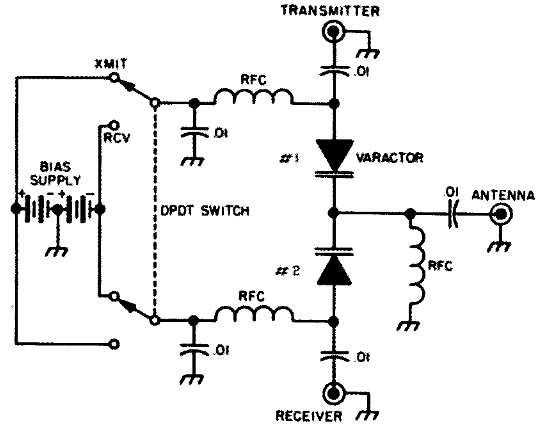


Fig. 15. Two varactor transmit-receive switch.

the diode can safely switch is dictated by its power dissipation and series resistance. Since the series and shunt diode circuits operate in somewhat opposite ways, it would not be unusual to expect that their power ratings might be different. This is indeed the case and it is interesting to note that although the shunt circuit has twice the peak power rating as the series circuit, its average power rating is only one-quarter as much as that of the series arrangement. For 50 ohm coaxial transmission lines operating with an SWR of 1:1, the respective power ratings may be calculated from the following equations:

Series	**Shunt**
Peak Power $= (\mathrm{PIV})^2/1600$	Peak Power $= (\mathrm{PIV})^2/400$
Average Power $= 25\ P_d$	Average Power $= 6.25\ P_d$

Where: PIV = Peak inverse rating of the diode (volts)
P_d = Power dissipation rating of the diode (watts)

From these formulas it can be readily found that to control the peak power of a 1000 watt CW transmitter operating at 70% efficiency (700 watts into the transmission line), a series diode would require a PIV of 1058 volts; under the same conditions a shunt switching diode would require a PIV of 529 volts. For insurance against blowing the diodes under peak power loads or SWR changes, a safety factor of 50% should be added to these figures.

In addition to the strictly off-on capabilities of varactor rf switches, they may also be used as voltage variable attenuators and amplitude modulators. As voltage variable attenuators they operate somewhat differently than normal attenuators in that they are not absorptive. Whereas most attenuators consist of resistance networks which provide attenuation by absorbing rf power and dissipating it in heat, the diode attenuator operates on the reflective principle in exactly the same way as the diode switch, with attenuation being directly proportional to the amount of bias across the diode. The direction of bias of course is determined by the circuit configuration, series or shunt.

Varactor amplitude modulators are just an extension of the attenuation principle. In the attenuator, the bias consists of an adjustable source of dc voltage. In a modulator, the diode bias is modulated by the audio output of a microphone amplifier. As the bias is varied at the audio frequency, the attenuation of the diode circuit varies in exactly the same way. Therefore, the magnitude of rf power passing through the attenuator is directly proportional to the modulating audio voltage and we have an amplitude modulated wave. These applications are particularly well suited for the upper UHF and microwave frequencies where attenuators and amplitude modulators are difficult to build with normal run of the mill components.

Circuit tuning

Since varactor capacitance varies from very small values when reverse biased to very large values when forward biased, these diodes may be used to electronically tune rf amplifiers, local oscillators, filters and preselectors. The only limitation is that the circuit which the varactor tunes must be small-signal oriented; that is, the signal must be small compared to the bias across the varactor. This becomes obvious when we consider that if the circulating r-f energy is more than about 10 milliwatts, the varactor will start to act like a limiter.

The simplest method of tuning is to place the varactor in parallel with an inductor as illustrated in **Fig. 16A.** Here the varactor provides the total capacitance of the tuned circuit, but circuit Q will be quite low. Theoretically this arrangement is tunable from zero to the maximum frequency dictated by the minimum capacity of the diode, but circuit losses are high because of the low Q.

For amateur applications where tuning a complete band normally represents only 10% or less of the center frequency, a better arrangement is shown in **Fig. 16B.** Here the diode is in series with the capacitor C_1 and in parallel with the shunting capacity C_2. In this circuit the Q is increased by a factor of six.

An application of this circuit is the electronically tuned two meter rf amplifier illustrated in **Fig. 17.** With the constants shown and a microwave varactor, this circuit will tune the entire 144 mc band. The frequency is initially adjusted to the desired point with the variable shunt capacity C_2. After this initial adjustment, any tuning is accomplished with the 50 K potentiometer.

Although this circuit is oriented around a small capacity varactor, the same technique

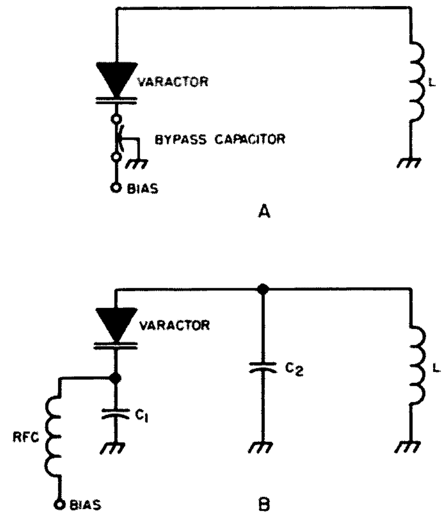


Fig. 16. Varactor tuning circuits.

may be applied to lower frequency circuits with regular varicap diodes. In this case, the series and shunt capacitors should be chosen so that they are about two-thirds the minimum capacity of the diode.

In addition to normal tuning duties, this type of circuitry has several other important applications. One of these is as frequency modulators of oscillator stages. As a frequency modulator the diode bias is actually modulated by a microphone or other external audio signal. The amount of frequency deviation is regulated by the amount of modulated bias placed across the varactor.

Summary

Although the circuits described in this article are predicated on the use of small capacity microwave varactors, in many cases, particularly at the lower frequencies, other diodes will work equally as well. Two 88¢ varieties that are recommended as starters are the 1N82A and 1N3182.

. . . WA6BSO

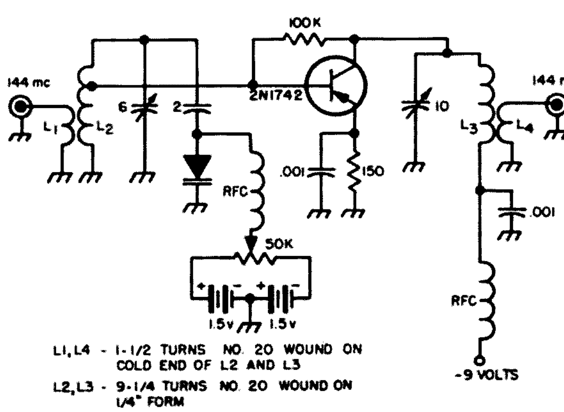


Fig. 17. Varactor tuned two meter amplifier.

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12 Volt Beetle Juice

For some time now in DL country it has been possible to obtain all Volkswagen models complete with a 12 volt ignition system. The generators on these models are rated at 450 watts. These units are being made to fill the ever-rising commercial demand for a heavier ignition system. Only the VW truck, however, is available in other parts of the world with the heavier, 12 volt ignition.

Those who now own Volkswagens with the 6 volt ignition can either convert the entire system to 12 volts (the 12 volt parts including generator, voltage regulator, starter motor, windshield wipers etc. are also available in Volkswagen garages outside of West Germany) or one can install a second generator rated at 12 volts. The accompanying 12 volt battery can be located behind the back seat, or when a small battery will do (12 volt, 50 ah) it can be installed under the left rear seat.

The generator mounting bracket on the 40 HP motor (since August 1960) can be simply unbolted from the block. This bracket must then be traded for a new one, built to accomodate two generators. (**Fig. 1.**)

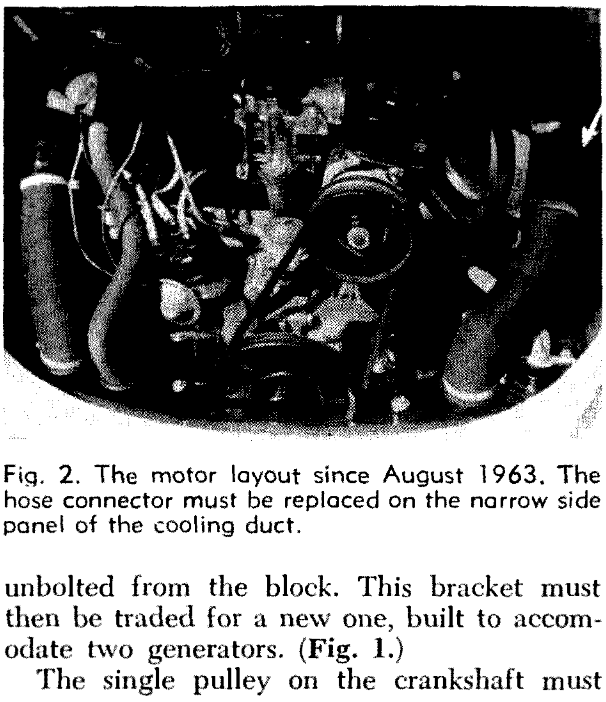

Fig. 2. The motor layout since August 1963. The hose connector must be replaced on the narrow side panel of the cooling duct.

The single pulley on the crankshaft must

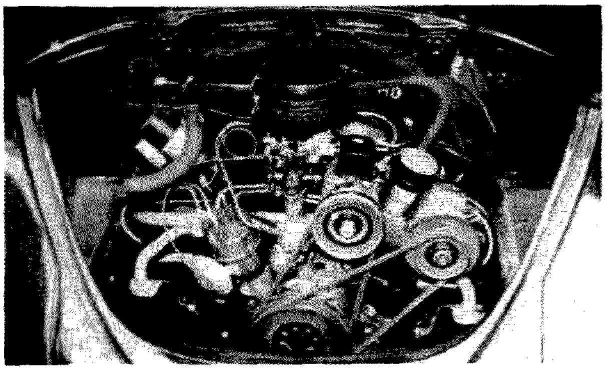

Fig. 1. Installation of second generator in models since August 1960.

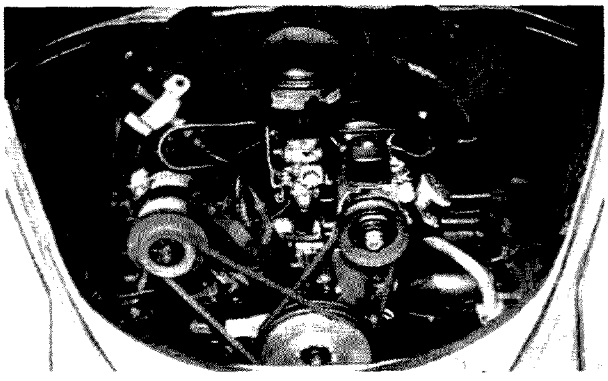

Fig. 3. Installation in the VW prior to August 1960.

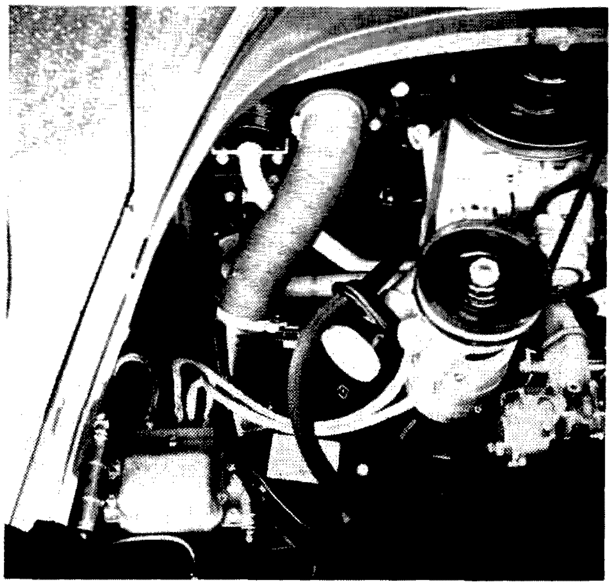

Fig. 4. The 12 volt VW as it comes from the factory.

be removed, and bolted to another of the same size. The voltage regulator for the new 12 volt generator sits to the right, next to the cooling duct on the partition between the motor and passenger compartments.

In 1963, the heating system in the VW was altered. If one wishes to install the double generator mount in this model, the heating hose connector must be relocated to the right on the side wall of the air duct. (**Fig. 2.**) Otherwise, there is no free space for the installation of the second generator. The heating hose must also be lengthened a little.

In the VW Export, previous to 1960, the mounting for the second generator is accomplished with several adjustable arms, and is located above the distributor and fuel pump. (**Fig. 3.**)

The ignition coil must be relocated somewhat higher. Also, the fuel line, from the pump to the carburator, must be bent somewhat differently. The pulley installation is identical to that in the other models. The second voltage regulator now sits to the left of the cooling duct on the forward wall.

In all models, the Bosch LJ/GEG 160/12 2600 R 1 (160 watt) generator with accompanying RS/UA 160/12 voltage regulator, or the 12 volt VW generator is used. If the VW generator is used, the rear shaft must be trimmed off to a suitable length.

The different pulleys are supplied by the Bosch firm. The mounting bracket in **Fig. 1** was fabricated here at the QTH.

These installations have proven to be very satisfactory; and I will gladly be of help in supplying the different parts.

. . . DJ2UL

The HD-10

Heathkit's new electronic keyer

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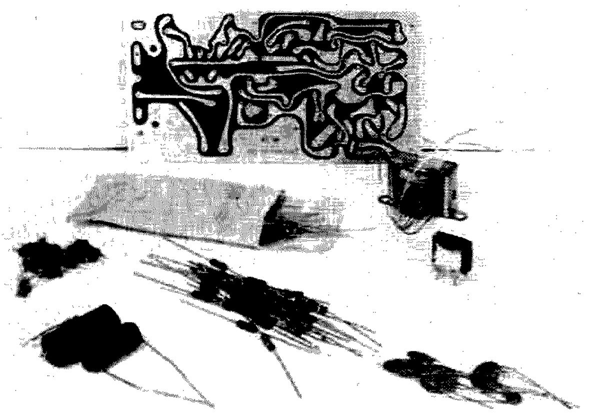
Recognizing CW's popularity—it's far from dead, despite the claims of the ssb boys—Heathkit has produced an electronic keyer kit that will gladden the heart and tickle the ears of every CW man. Yes, you too can send beautiful, effortless, perfectly formed code. For the benefit of those who still pound away at a straight key or use a bug, you can send for hours with this keyer without strain or fatigue.

Benton Harbor's latest goodie was especially interesting to me because its circuit is based on the W30PO transistorized keyer which first appeared in QST for December, 1962. Until then, I had used several conventional keyers, all of which were alike in that they keyed the rig through a relay. Inevitably, relays meant trouble. Sooner or later, contacts got dirty or needed readjusting. The W30PO job boasted of one feature that sold me—instead of a relay, a switching transistor was the keying medium. No moving parts. Nothing to foul up. Hallelujah! It has worked like a charm ever since.



The HD-10 kit utilizes the printed circuit board shown here. Almost 90 parts mount on it—including the power transformer at right, rear.

Heath's designers improved that circuit, added a few ingenious touches of their own, squeezed in a paddle and packaged the whole thing in a neat little box only 3¾x4¼x10½ inches, painted in the now traditional colors—two-tone (Wayne?) green, same as the SB100, 110, 200, 300, 400 . . . and who knows what's to come? There's still a lot of numbers left.

It was a pleasure to assemble this kit. Although the number of parts is surprisingly large (there are 49 resistors, 18 capacitors, 6 diodes, 11 transistors and 2 transformers), a single circuit board takes care of everything except a few odds and ends, such as speed and monitor volume controls, pilot light, etc.

As I've come to expect from Heath, the instruction manual is a model of clarity. Success is assured by following the instructions and soldering properly. And, speaking of soldering, Heath now includes in their kits a new full-color booklet that is a complete course in soldering and kit-building.

Now, to the kit! There's no point in covering the assembly details here; that's the function of the manual. I'd suggest only one thing that the manual doesn't mention. The screws which fasten an eight lug terminal strip to the rear panel are also used as binding posts for ground connections. Before attaching the strip, sand the paint from the inside face of the back

panel, to assure a good ground. Do the same where the phone jack mounts.

The built-in paddle is simple and ingenious and more than adequate for keyer beginners. (See photos for details of its construction). Once you've become skillful, you'll probably want to switch to a paddle that has more precise action and is easily adjusted. Thinking ahead, Heath has provided for attaching an external paddle to the rear panel.

By changing jumpers and connections on the rear panel you can have any mode of operation you can think up, plus a few you never suspected. Here's what the keyer can do:

1) Choice of built-in or separate external paddle

2) Conventional operation; automatic dots and dashes

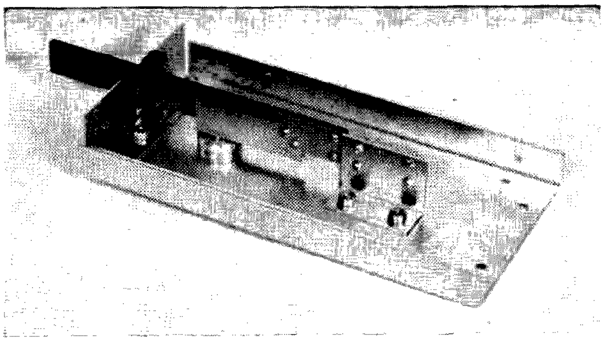
3) Automatic dots and manual dashes

4) Hand key or bug can be attached externally.

Flexibility extends to monitoring also. The built-in sidetone generator can be heard through its self-contained speaker or through earphones plugged into the rear panel jack. For deluxe on-the-air monitoring, feed the receiver audio to the keyer. When the station is in "receive" condition, you hear the receiver through the phones plugged into the keyer. Switch to "transmit" and the sidetone is heard through the same phones when you key.

The kit took only 4½ hours to assemble, including the time I spent taking photographs, so you can see it isn't a major project. It worked fine first try, but one diode opened about ten minutes later. Once replaced, however, no further trouble was encountered.

The dot-space ratio is adjusted in seconds with the help of a VTVM or a 'scope and the circuitry assures that dashes will be exactly three times as long as dots. The adjustments hold throughout the full speed range. You



Paddle subassembly complete except for handle. Strips of spring brass provide adjustable tension and the small snap switches used for contacts may be adjusted for desirable spacing.

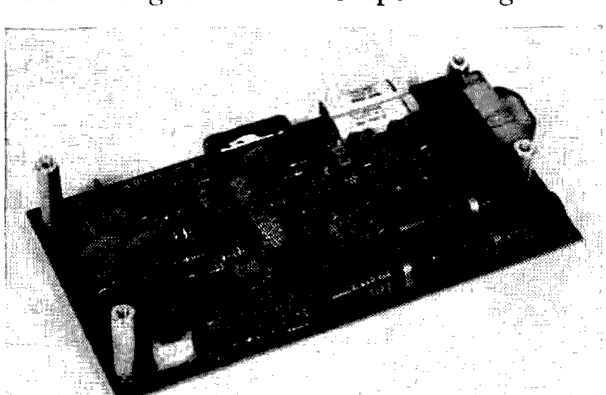
have your choice here too—two pairs of resistors are furnished; one gives 10 to 20 wpm, the other 15 to 60 wpm. You wire in the pair for the range you want.

The Heathkit HD-10 keyer can handle any transmitter using grid block or other types of keying where a negative voltage is shorted to ground to key the transmitter. The keying transistor, a 2N398A, is rated to handle a maximum of −105 volts at 35 ma. Make sure the current and voltage at your key terminals are within these limits. Slightly higher ratings can be had by substituting a type 2N398B, about $1.45 at most parts jobbers.

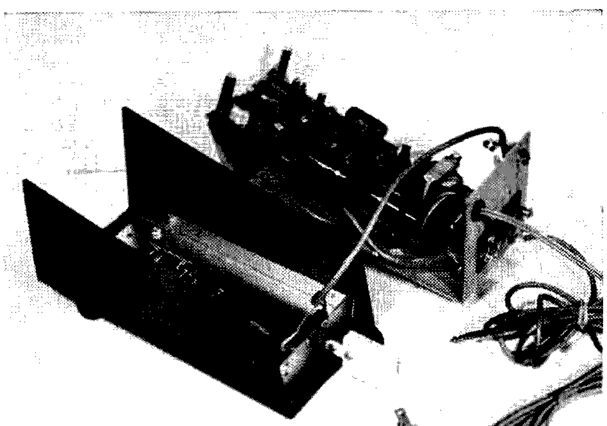
In most installations the built-in 110 volt ac power supply will be adequate. For portable or emergency use, however, two 22½ v. batteries in series, or one 45 v. source tapped at 22½ v. will do the trick. Overseas hams can adapt the ac power supply to 230 v. by inserting a .068 μf 600 wvdc capacitor in series with one leg of the line cord.

As good as my W3OPO keyer was, this one is even better. One of my buddies—an old, old timer—instantly recognized the improvement without knowing I was using a new keyer.

. . . W2JDL



Completed board with all parts soldered and four metal spaces in place. The spacers support the board upside down in the case.



Ready for final assembly with all parts completed. Circuit board mounts upside down over paddle. Metal cover with control panel follows last.

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Solder and Soldering

Soldering is one of the oldest and simplest methods of joining electronic components. Because of its simplicity and ease of application, it is often used, but seldom studied or analyzed. Have you ever studied solder or the art of soldering? The subject is very important and deserves a little more attention than most amateurs give it. Murphy's law (If anything can go wrong, it will,) applies to soldering. If taken for granted, soldering can cause trouble.

Alloys

Soft solder, consisting mainly of tin and lead, is used for most electronic assembly. Soft solders make connections by virtue of a metal solvent action that takes place at low temperatures. The solvent action makes solder joints chemical in character rather than purely physical.

Fig. 1 shows a tin-lead fusion diagram. From this diagram, it is evident that the addition of tin to pure lead lowers the melting point of the alloy until an alloy of 63% tin—37% lead is reached. This alloy has the lowest melting point (361° F) and is known as the eutectic alloy. The eutectic alloy does not pass through a plastic state before it becomes molten. If more than 63% tin is added, the melting point temperature will begin to rise again.

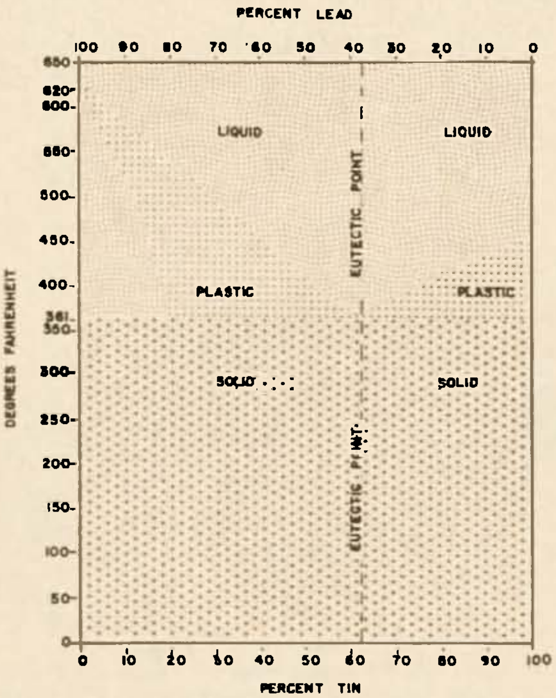

Fig. 1. Tin-lead fusion diagram.

Commercially available solders cover the entire range of tin-lead ratios from pure tin to pure lead. What is the best alloy for electronic asembly purposes? To answer this question, it should be remembered that the primary purpose of solder is to connect two or more metals, but resistance to stress and strain, speed of alloy formation, flow and spread of the solder, and chemical stability of the joint, must also be considered. There is no one alloy that is the answer to all problems but for electronic assembly there is a fairly large range of alloys that give good results; the exact choice is up to the individual. Alloys from 50% tin—50% lead to 60% tin—40% lead will give good results for most amateur needs. It is interesting to note that the best physical properties (stress and strain resistance) occur with an alloy of approximately 60% tin, and the lowest melting point occurs with 63% tin, but from a practical standpoint, any alloy with 50% to 60% tin will give good results.

Flux

All metals are covered with an oxide film. This film is nonmetallic and will prevent the metal solvent action (soldering) from taking place. Flux is added to the solder in order to remove the oxide film and allow the clean metal surfaces to make contact. The flux will remove only the oxides. It will not remove paint, dirt, or other foreign matter. The choice of proper flux is one of the most important steps in obtaining good solder joints. There are hundreds of different fluxes, but for the purpose of discussion, they will be divided into four groups: (a) rosin (b) activated rosin (c) organic (d) acid.

Rosin flux gives good fluxing action. This flux is corrosive only when heated to a molten state. The corrosive action is needed to remove the oxides from the components being soldered. When the heat is removed, the residue that is left is noncorrosive and electrically nonconducting.

Activated rosin fluxes have a more effective fluxing action than pure rosin. They were developed to meet the demand for a faster more efficient soldering process. The residues should be noncorrosive and nonconductive. Be careful when purchasing activated rosins, some of the advertising is misleading.

Organic fluxes are more effective than rosin or activated rosin but they leave corrosive residues. These fluxes are used when the fluxing action of rosins is insufficient and when small amounts of corrosion may be tolerated. The residues should be removed.

Acid fluxes are the most effective but they leave corrosive and electrically conductive residues. The word "acid" is a misnomer since the fluxes are actually salts. The residues absorb moisture from the air and the corrosive action is probably due to galvanic or electrolytic action. These fluxes are used only when their great activity is needed. Kit manufacturers will not guarantee their kits if acid core solder is used.

The choice of a flux can be a complicated problem, but you will not go wrong if you choose the least active flux that will give good results for your particular application. For electronic assembly, pure rosin or some of the activated rosins would be the best choice.

Soldering

After the choice of a proper alloy and flux, good soldering becomes a function of the individual's technique. For good solder joints the following must be observed:

Fig. 2. Application of solder.

1. Use the proper alloy and flux.
2. The soldering iron must of sufficient wattage rating. (Don't try to use a 25-watt pencil iron to make a connection to a ground lug on a large aluminum chassis and don't use a 125-watt gun type iron on a printed circuit board.) The iron should have a bright, smooth, tinned tip for most efficient heat transfer to the joint. Clean the tip periodically.
3. All elements of the joint should be clean. (No dirt, paint, grease or other foreign matter.)
4. Use the iron to heat the joint and apply the solder to the junction of the tip and the joint. (**See Fig. 2.**) Remove the iron when the solder wets the joint. Don't use excessive solder. The joint must not be jarred or subjected to vibration before the solder cools. Such motion will cause cold solder joints.
5. Inspect each joint. A properly made joint has a smooth appearance and a satin-like luster. Wiggling the components of the joint by hand or with pliers will also help make sure the joint is a good one.

Given the proper tools and a little experience, anyone can make good solder joints. Because of the simplicity of soldering, many people take it for granted and never bother to learn the fundamentals. Soldering is simple, but it can cause trouble. The failure of a solder joint is the same as the failure of a component, but it can sometimes be much harder to find. Don't let a few cents of solder ruin the performance of hundreds of dollars of electronic equipment.

. . . K4CPR

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The Rhombic Antenna

The rhombic antenna has been used as a directive antenna system almost as long as "Wireless" or radio broadcasting. Phil Rand W1DBM, first built and operated a rhombic for amateur communications way back in 1931!

The purpose of this article, therefore, is not to bring you a new antenna development, but rather to acquaint, or re-acquaint you with the construction and operation of this outstanding antenna.

No single antenna array, regardless of its size, shape, or electrical characteristics, is capable of producing the ultimate in gain and/or directivity, when operated over a wide span of frequencies. The rhombic however, probably comes closer than any other antenna to meeting these criteria. **Fig. 1** lists the gain of rhombics of various leg lengths.

Before continuing further let's define just what a rhombic antenna is. A rhombic antenna is a form of long wire antenna, or to be more exact, a combination of long wires, so constructed as to produce maximum gain per unit of length. This long wire type antenna can be considered as two V beam antennas placed end to end, or two obtuse angle V beam antennas placed side by side to form a rhombus, or diamond. (See **Fig. 2**).

leg length (wave lengths)	*db gain*	*leg length (wave lengths)*	*db gain*
2	7.4	7	13
3	9	8	13.5
4	10.5	9	14
5	11.5	10	14.5

Fig. 1. Approximate gain (in decibels) for maximum output rhombics compared to a half wave dipole at the same elevation.

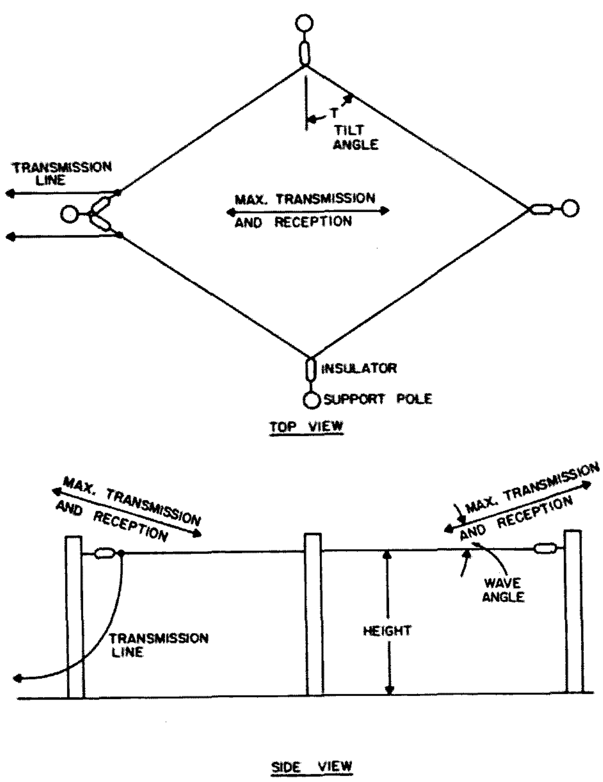


Fig. 2. The rhombic antenna.

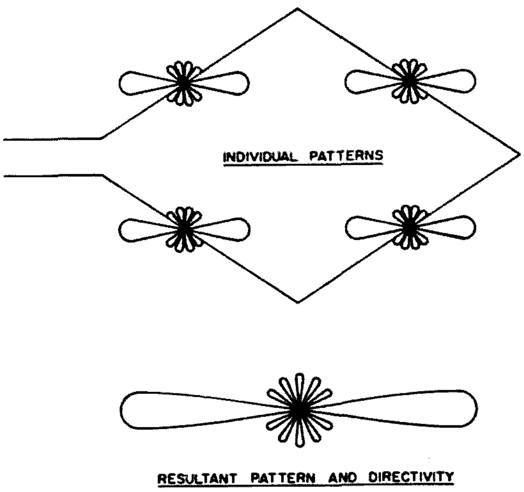


Fig. 3. Bi-directional rhombic.

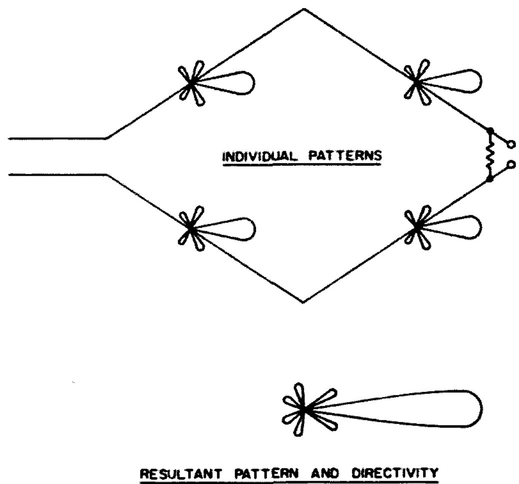


Fig. 4. Uni-directional rhombic.

The rhombic antenna is usually oriented in the horizontal plane, and in its basic form, produces a horizontally polarized bi-directional pattern, with maximum radiation occurring at some vertical angle above the plane of the antenna. This angle of radiation, or lobe, is called the wave angle, and is shown by the Greek letter delta (Δ). The *tilt* angle, or *T*, is one half angle between the two legs making up one side of the antenna.

Fig. 3 shows the rhombic with a bi-directional pattern. This bi-directional pattern results because a part of the energy traveling from the input, or feeder end of the antenna, toward the far end of the antenna, is reflected back, producing standing waves on the antenna legs. Because of these standing waves, this type is known as a resonant rhombic.

In order to make a rhombic uni-directional, it must be terminated with a non-inductive resistance of the proper value. The function of this terminating resistance is to absorb any energy that might be reflected back toward the feeder, or input end of the antenna. The terminated rhombic, therefore, is non-resonant. Termination of the rhombic, in addition to making it uni-directional, provides a feed, or input impedance which is constant over a wide range of frequencies. (See **Fig.** 4)

We will get back to the fine points of termination, and other aspects of design and layout of the rhombic, but right now, let's take up the advantages of this antenna array.

Some of the advantages of this antenna are as follows:

a. Produces excellent results over a frequency range of 4 to 1 (80–40–20–15 meters, for example).

b. Is easier to erect and maintain than other antennas of comparable gain and directivity.

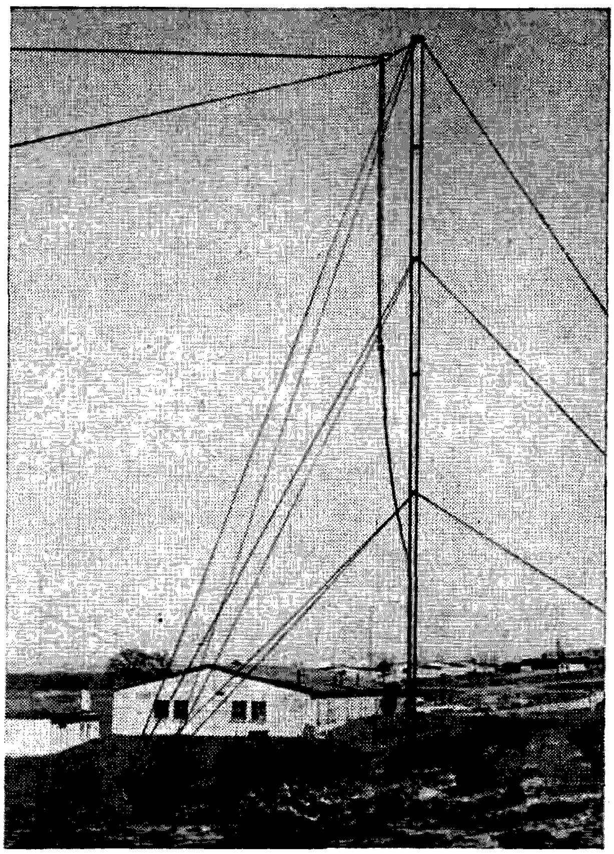
c. Is non-critical in operation and adjustment (broad tuning).

d. Can be made uni-directional by use of a terminating resistance.

On the disadvantage side, these are some of the factors to consider:

a. A large space is required for erection.

b. When terminated with a resistance, approximately 35 to 45% of the power fed to the antenna is dissipated in the termination resistance.


Rear pole with ¼ wavelength stub and coax balun for DL5UW's 20 meter rhombic.

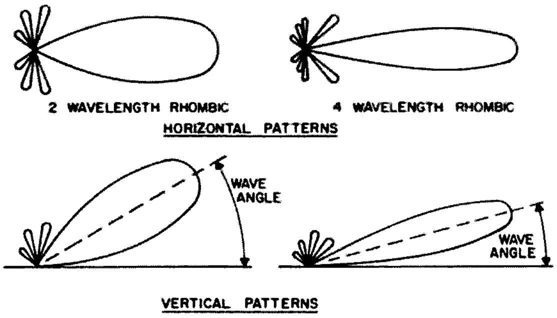


Fig. 5. Vertical and horizontal patterns of rhombics.

c. The horizontal and vertical patterns are interdependent, thus, for example, a rhombic designed to produce a narrow horizontal beam will have a fairly sharp and low vertical pattern. (See **Fig. 5**).

There are two main types of design for a rhombic antenna. One is known as the maximum output design, and the other as the alignment design. As the name implies, the maximum output design rhombic produces maximum gain if certain design parameters are adhered to. If, for example, we desire to cover a 4000 mile path, with a two-hop skip, we might choose a vertical wave angle of 15 degrees and design the antenna around this figure. In order to have the antenna produce maximum power at this vertical wave angle of 15 degrees, we must use certain valves of leg length, tilt angle, and height above ground. Any variation from these valves, will reduce the gain at the desired wave angle.

These computations for a maximum output rhombic, with a 15 degree wave angle are as follows:

$$\text{H (Height in wave lengths)} = \frac{1}{4\ \sin\Delta}$$

$$\sin\Delta = .25882$$

$$4\ \sin\Delta = 1.03528$$

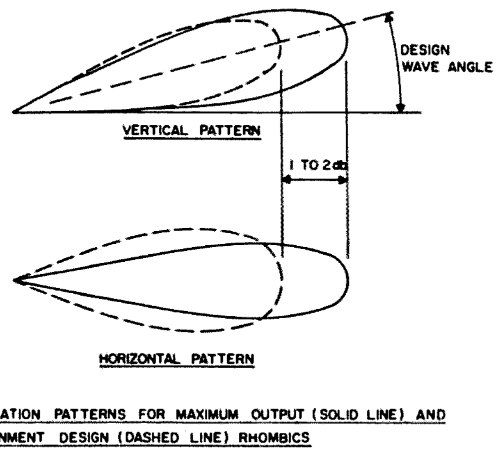


Fig. 6. Differences in patterns between maximum output and alignment rhombics.

$$H = \frac{1}{1.03528}$$

$$H = .97$$

$$\text{L, leg length} = \frac{1}{2\ \sin^2\Delta}$$

$$\sin\Delta = .25882$$

$$\sin^2\Delta = .066466$$

$$2\ \sin^2\Delta = .13398$$

$$L = \frac{1}{.13398}$$

$$L = 7.4649$$

$$\text{Tilt Angle, or } \phi \text{ (PHI)} = 90^\circ - \Delta$$

$$\phi = 90^\circ - 15^\circ$$

$$\phi = 75^\circ$$

When a sufficiently large antenna site is not available for a maximum output rhombic, the leg length can be made about 74 precent of the maximum output leg length, or by

$$\text{formula L, or leg length} = \frac{.371}{\sin^2\Delta}$$

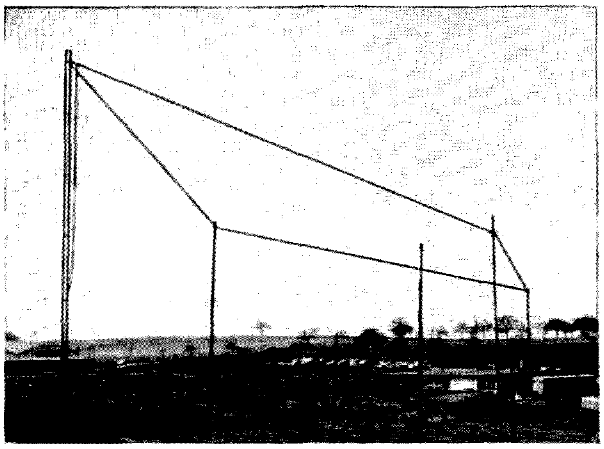
This shortened leg rhombic is known as the alignment design rhombic. The height, and the tilt angle are the same for any given wave angle for both maximum output and alignment designs.

Using the alignment design, there is a small reduction in gain. This gain reduction amounts to about one to two db, in most cases. The horizontal pattern of the alignment design rhombic is some what broader, and the vertical pattern somewhat sharper than that of the maximum output design. In addition, the maximum output design rhombic produces a vertical radiation pattern which, in practice, falls a few degrees lower (or less) than the design angle. For example, our rhombic designed for a vertical angle of 15 degrees, will produce a vertical lobe centered on, perhaps 13 degrees (See **Fig. 6**).

Fig. 7 gives values for both the maximum output and alignment design rhombics.

In military point to point communications, we use several sizes of rhombics that can be utilized for amateur operation. These rhombics were designed to cover a frequency range of 4 to 22 mc. (See **Fig. 8**).

You will notice that the dimensions of these antennas do not necessarily conform to those listed in **Fig. 7**. The reason for this difference is that these rhombics utilize what is known as a compromise design. The compromise design



5 wavelength 20 meter rhombic at DL5UW.

provides good gain over a fairly wide frequency range, and at the same time employs reasonable physical sizes and heights.

In our discussion, and diagrams of various rhombics, we have used a single wire or conductor to form each leg of the antenna. Commercial, military, and in some cases, amateur rhombics employ multi-element legs. These multi-element legs are normally made up of three wires of equal length and fanned out from the rear and front poles so that they have a spacing of about 6 feet (vertically) at the point of attachment to the side poles. (See Fig. 9). The multi-wire or curtain rhombic has the following advantages over the single wire type.

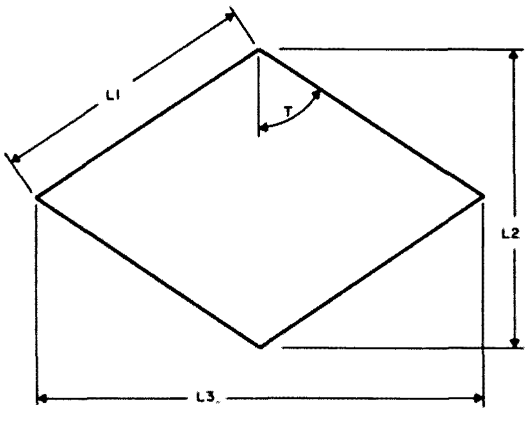


Fig. 8. Compromise design rhombics for 4 to 22 mc.

L1 *Leg Length* *(feet)*	*L2* *Width* *(feet)*	*L3* *Total Length* *(feet)*	*T* *Tilt Angle* *(degrees)*	*H* *Height* *(feet)*
* 375	256	705	70	65
350	241	658	70	60
315	221	590	70	57
290	222	537	67.5	55
270	228	490	65	53
245	226	437	62.5	51
225	225	391	60	50

*** This is approximately the same antenna as the one used so successfully at DL4OV. Converting the 375 foot leg length to wavelengths, we have one wavelength per leg on 3.9 mc, 2½ on 7 mc, 5 on 14 mc and 8 on 21 mc.**

Wave Angle (degrees)	*Leg Length (wave lengths)*	*Tilt Angle (degrees)*	*Height (wave lengths)*
10	17	80	1.45
12	11.5	78	1.20
14	8.5	76	1.04
16	6.6	74	.91
18	5.3	72	.81
20	4.3	70	.73
22	3.7	68	.67
24	3	66	.62
28	2.3	62	.53
30	2	60	.50

Fig. 7A. Maximum output rhombic antennas.

Wave Angle (degrees)	*Leg Length (wave lengths)*	*Tilt Angle (degrees)*	*Height (wave lengths)*
10	12	80	1.45
12	8.5	78	1.21
14	6.3	76	1.04
16	4.9	74	.91
18	3.9	72	.81
20	3.2	70	.73
22	2.6	68	.67
24	2.3	66	.63
26	2	64	.57
28	1.8	62	.53
30	1.6	60	.50

Fig. 7B. Alignment design rhombic antennas.

a. The input impedance is more nearly constant over a wide range of frequencies.

b. The input impedance is reduced to a lower value, allowing a good match to 600 ohm open wire line feeders.

c. The 3 wire rhombic produces about 1 db greater gain than the single wire type.

The value for termination of a single wire rhombic is about 800 ohms. When this 800 ohm value is used, the input impedance of the antenna is approximately 700 to 750 ohms. This difference is caused by radiation losses in the antenna. The rhombic can be terminated with non-inductive resistors, such as the carbon type. These resistors are available in power ratings of 100 to 200 watts. One combination of resistors for a single wire rhombic is seven 100 watt, 5200 ohm carbon resistors paralled to make a 700 watt, 740 ohm termination resistance. This 700 watt rating will handle a transmitter running a full kilowatt and allow a 50 percent safety factor. Another type of termination consists of a dissipation line. Dissipation lines are sometimes constructed with a pair of number 15 AWG solid stainless steel wires, spaced to provide proper termination impedance. The advantages of this line is that it is 1000 feet long. A more suitable dissipation line can be constructed with number 24 to 26 nichrome wire 250 feet long, with a 20 watt 800 ohm carbon resistor across the far end of the line. (Ten 8000 ohm 2 watt carbon resistors in parallel, for example). Because of the power attenuation in the 250 feet of nicrome wire, the 20 watt resistor will not be overloaded.

The terminated rhombic can be made to switch its beam, or lobe direction by 180 de-

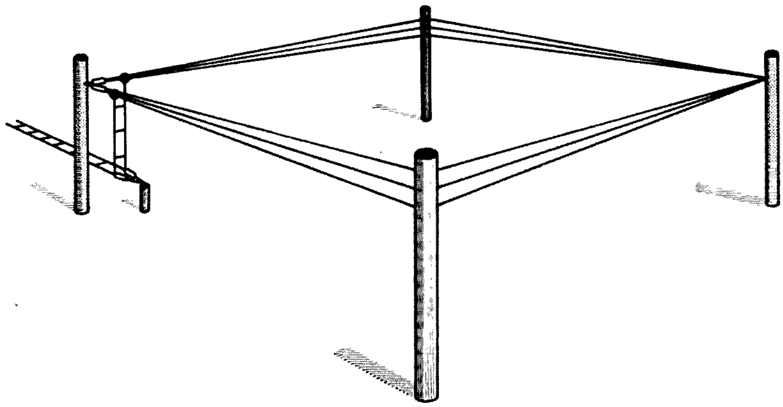


Fig. 9. Three wire rhombic.

grees when the following components are incorporated in the system. First, transmission lines are run from the transmitter to both ends of the rhombic. Then a dissipation line is constructed and the open end brought into the shack, or operating position. If two double pole double throw relays, or switches are employed, the proper transmission line, and the dissipation line can be connected for transmission in either of two desired directions. This switching system is shown in **Fig. 10.**

The resonant, or bi-directional rhombic, unlike the terminated model, must be fed with resonant, or tuned feeders, when operated on more than one band. Open wire line, such as number 14 AWG spaced 6 inches, tuned with a "match box" type of antenna tuner will do the job. When the resonant rhombic is operated on one band only, a matching stub and coaxial cable with a coaxial balun, can be used to feed the antenna.

Good engineering practice calls for a site, or plot of ground that is level and free of obstructions under, and near the rhombic antenna. This, of course, is an ideal situation for installing a rhombic, or any antenna, for that matter. If a rhombic is erected over ground that slopes down evenly toward the front pole, the amount of slope, in degrees, is then subtracted from the design wave angle of the antenna. For example, if a rhombic designed for a 20 degree wave angle is erected parallel to the ground with a 5 degree downward slope, the resultant wave angle will be 15 degrees in the direction of the low end, and conversely the wave angle, if the antenna is bi-directional, will be 20 plus 5 degrees, or 25 degrees from the high end. Another variation, used frequently by radio amateurs, is erection of the rhombic over level ground employing poles of various heights, thereby tilting the entire antenna in respect to ground, in the direction that a lower wave angle is desired. For example, a rhombic with 290 foot legs, and a 67.5 degree tilt angle, (Approximately 493 feet from rear to front pole) when erected on level ground with a 70 foot rear pole, 50 foot side poles, and a 30 foot front pole, will have a slope or tilt in the horizontal plane of about 4.5 degrees.

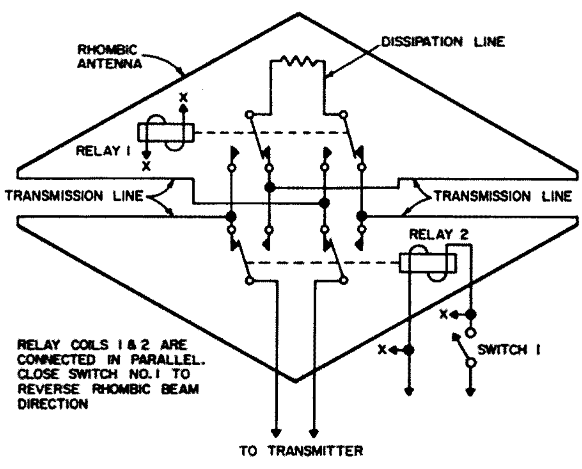
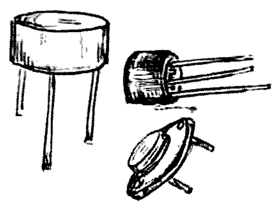


Fig. 10. Switchable terminated rhombic.

Rhombics and V beams that are sloped, or tilted in the horizontal plane so as to produce a lower wave angle in on direction are very successfully operated by W1DBM, 5H3JR, W1BCR and the author, to name but a few.

Many of us are not fortunate enough to have the space required for a rhombic, but that place out in the country, that you've had your eye on, might just solve that problem. We will all be listening for that nice, big, fat signal from your new diamond shaped antenna. . . . WØSII



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Vocap Tester

This writer has been in orbit so long since his last blast-off that he got lonesome, so he decided to build a music maker. Well not exactly, but a few notes are played while tests are being accomplished. At least it talks back and keeps you company.

The unit is an electronic tester which tests volts, ohms and capacitance without the need of your visual facilities; however your aural facilities must be turned on and in operation. It may be used where total darkness is a requirement or if two meters cannot be monitored simultaneously. Also, a new field may be used where total darkness is a requirement or if two meters cannot be monitored simultaneously. Also, a new field may be opened to the blind.

The unit employes a built-in calibrated tone for each measurement. The item being tested will produce a certain tone and the internal tone calibrator is adjusted until its tone is the same frequency as the tone produced by the item under test. The value of the calibrator will then be equal to the value of the item being tested. It will measure up to 1000 volts dc and also determine polarity, resistance up to 630K ohms and capacitance from 150mmfd to 11mfd.

The VOCAP tester utilizes an audio oscillator which is varied in frequency in accordance with the unit being measured and the internal calibration circuit is adjusted until the calibration tone is identical to the tone produced by the unknown unit. The value of the unknown unit is then equal to the internal calibrated value.

This tester may be used in a dark room; at such a distance, one could not see a meter; while checking two circuits (one with a meter and the other audibly); by a blind person, and by other facilities.

An additional audio oscillator could be built into this unit as a calibrated unit and its tone varied to zero beat with the tone produced by the oscillator controlled by the unknown unit being measured. Again the measured value would be equal to the calibrated unit.

Circuit

The audio oscillator and amplifier use a total of three similar 2N34 transistors. A simple transistorized audio oscillator is the heart of the unit and feeds a signal to a two stage RC coupled audio amplifier which drives a 2½ inch speaker with plenty of volume.

The frequency of the oscillator must be varied over a wide range to obtain greater accuracy from the calibrator system. The fre-

quency of this oscillator can be varied from a few cycles to approximately 5000 cycles. Now there are several ways to change the frequency of this oscillator. Some of the easier ways are: Change the supply voltage, change the voltage applied to the base, change the ratios of the oscillator condensers or change the resistance from transistor base to ground.

The problem of what type of calibrate system should be used raised its ugly head. A bridge type null detector and also a comparative type calibrate system was considered. The unit started out as a volt-ohm tester so a comparative type calibrate system was used, because only changing the base resistance to ground sounded very appealing and simple. Then later, it was realized that when a condenser was placed in parallel with the condenser connected to the base of the transistor oscillator, a frequency change was noted. However, a similar tone was difficult to obtain by changing the base resistance. So due to lack of patience, the problem was solved by using a capacitor comparative calibrator.

The voltage calibrate circuit was the most difficult to design. It was desirous to have one set of calibrate resistors that would work for all voltage ranges. Voltage divider networks were designed that did accomplish this function. It was also designed so the audio oscillator would cease oscillations when the upper voltage limit of each selected scale was obtained. Another added feature, due to the diode and circuitry arrangement, provides a means of determining the voltage polarity. The voltage calibrate switch values are not additive, i.e., only one switch is used to determine the voltage being measured.

The resistance calibrate circuit is very simple. The resistor being checked is inserted in series with the audio oscillator base lead and a comparative circuit is used to determine the value.

The capacitor calibrate circuit is similar in operation to the resistance test except condensers are connected in parallel with the condenser that is in the base circuit of the audio oscillator.

The resistance and condenser calibrate switch values are additive, i.e., a combination of the switch settings will determine the value of the item under test.

Construction

The placement of parts is somewhat critical if it is desired to use a 6 x 8 inch utility box. It is possible to use an all-resistor calibrate system. Some of the resistor values are not standard, so you must get a resistor with a value close to but lower in resistance and then file or saw a notch into the resistor until the resistance has increased to the exact value. Be sure and check the resistance often and

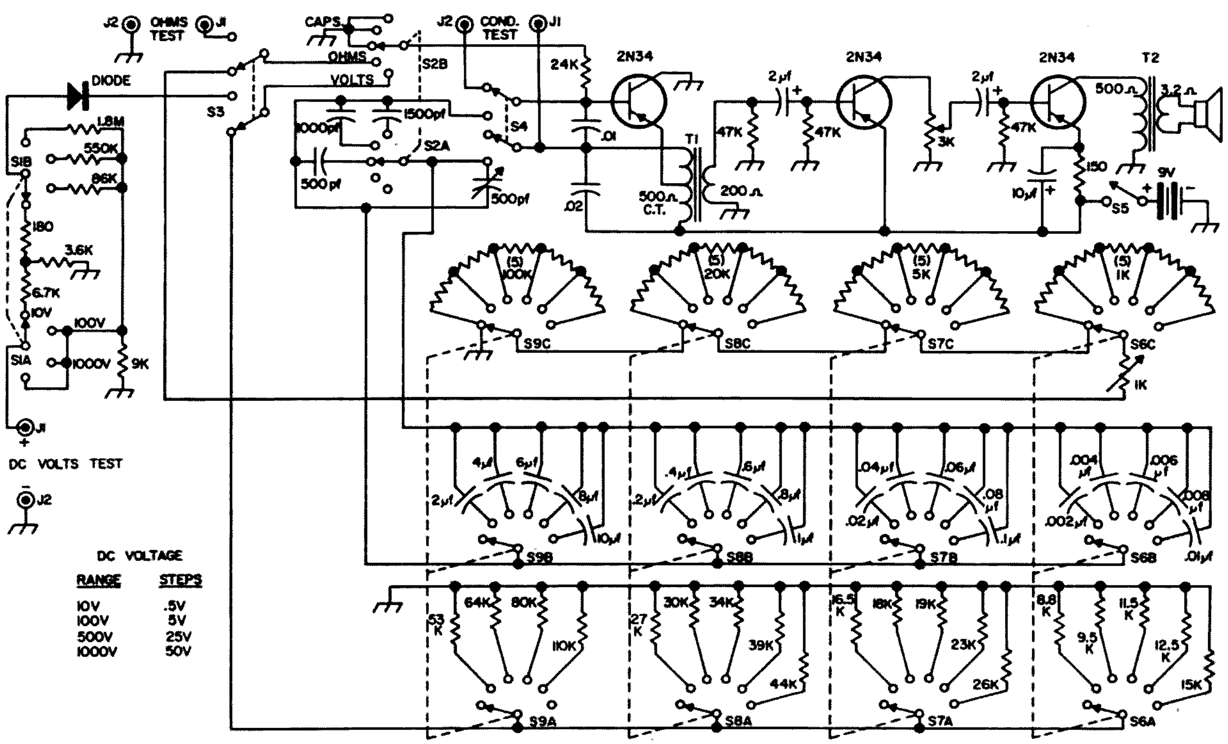


Fig. 1. Schematic of the Vocap Tester.

do not file it too much between checks or you may find that you have passed the point of no return. Apply a drop or two of glue to reseal the resistor to prevent resistance change due to moisture, etc. A new Eico VTVM was used to measure the components and the 1K ohmic scale range was used for measurements up to and including 25K ohms. The 10K ohm range was used for values above 25K ohms.

Low voltage condensers may be used which will reduce the size of components. Condensers were used for the calibrate system because the paralleling of condensers would provide a wide range of values.

A bridge type rectifier may be used if ac voltages are to be measured. An ac voltage measurement circuit was not included in the original unit but the writer is in the process of including one in the present VOCAP tester along with an ammeter circuit.

A nine-volt battery must be used with this unit because the calibration system was designed around a nine-volt battery source.

The on-off switch should be included in the volume control and the 365 pf variable condenser should be replaced with a 400 pf variable condenser for easier calibration of small capacitors. The three paralleling condensers would have to be changed to 100 pf, 600 pf and 1100 pf to give the same 500 pf, and 1500 pf ranges.

Operation

1. Voltage Test Procedure

The VOCAP tester is energized by the on-off power switch.

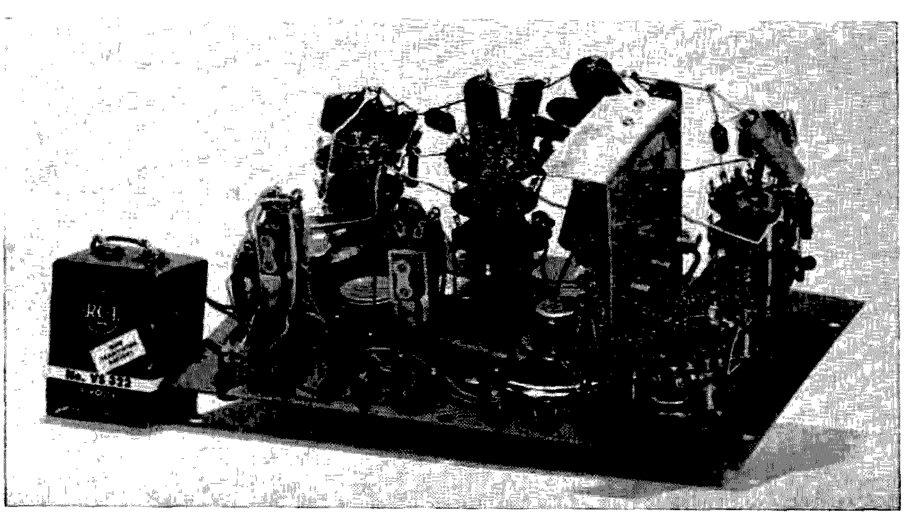
The following switches are used when measuring dc voltage: Voltage select switch, function switch, the four calibrate switches at the top, and the volt-ohm toggle switch. Place all calibrate switches to the OFF position, the function switch to "V" for volts, the voltage range select switch to 1000 volts and test leads connected to the volts terminals.

A tone will be produced, by the voltage under test, when the momentary volt-ohm toggle switch is depressed, which is the test position for checking voltages. The voltage select switch should be placed on the 1000-volt range if the approximate voltage under test is not known, to prevent the possibility of overloading the input circuit.

Correct dc polarity is first determined by connecting the test leads to the unknown voltage so as to produce the lowest pitched tone. The largest test lead jack is the negative terminal.

After polarity has been determined, the correct voltage range is selected by rotating the "volts" switch to the lowest range in which a tone can still be heard when the toggle switch is in test position. The voltage test circuit was designed so voltages greater than the upper limit of each range would cause the audio oscillator to cease oscillating. Example: if the test voltage was 250 volts, a tone will not be produced on the 10 or 100-volt range, but will be heard on the 500 and 1000-volt range. For greater accuracy, use the lowest range that produces a tone.

To determine the value of voltage under test, rotate only one calibrate switch at a time until the calibrate tone is approximately the same as the tone produced by the voltage under test. The value of the test voltage will then be equal to the value shown by the calibrate switch position. Be sure that three of the four calibrate switches are always in the OFF position. The 10-volt range is calibrated in .5-volt steps, 100-volt range in 5-volt steps, 500-volt range in 25-volt steps and 1000-volt range in 50-volt steps.



Here's the inside of the Vocap Tester. How's that for Mil Spec construction?

2. Resistance Test Procedure

Place all the calibrate switches to the OFF position, the function switch to "R" for resistance, the 1K ohm potentiometer to the zero position and connect the test leads to the "Ohms terminals. Connect the test leads across the resistor to be tested and momentarily depress the VOLT-OHM toggle switch. A tone should be heard. Now, adjust one or more of the calibrate switches (plus the 1K ohm potentiometer if required) until the same tone is produced. By adding up the values of each calibrate switch position, the total will then equal the value of the resistor under test. The 1K ohm potentiometer could be calibrated every 100 ohms for greater accuracy. The range of the resistor calibrator is apprroximately 100 to 630K ohms.

This range could be increased by increasing the number of positions on the left calibrate switch and adding additional 100K ohm resistors. The calibrate switches, from left to right, insert the following resistances in series: (1) 100K ohms each step, (2) 20K ohms each step, (3) 5K ohms each step, and (4) 1K ohms each step.

3. Capacitance Test Procedure

Place all the calibrate switches to the OFF position; the function switch to the 500, 1000 or 1500 pf range if small capacitors are to be measured, and if larger capacitors are to be measured, place the function switch to 500 pf range; place the 365 pf variable condenser to the "Min." (minimum) position and connect the test leads to the capacitor terminals. To determine the value of an unknown capacitor, connect it to the test leads and a change in the frequency of the audio tone should be noticed immediately. Now, depress the capacitor toggle switch and adjust one or more of the calibrate switches (plus the 365 pf variable condenser if required) until the same tone is produced. By adding up the values of each calibrate switch position, the total will then equal the value of the condenser under test. The variable capacitor could be calibrated every 100 pf for greater accuracy. The range of the capacitor calibrator is approximately 150 pf to 11µf. This range could be increased by increasing the number of positions on the left calibrate switch and adding additional capacitors. The calibrate switches, from left to right, insert the following condensers in parallel with the audio oscillator condenser: (1) 2µf each step, (2) .2 µf each step, (3) .02 µf each step, and (4) .002 µf each step.

The writer wishes to thank Mr. Dick Azim, KØJEJ, for the fine job of photographing the equipment.

. . . WØBMW

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The Feedline Argument

One of the perennial arguments on the air is the one of "coax versus parallel line." Perhaps a little history and a few facts about the feeding of antennas might add some fuel and some intelligence to the discussions. Everything said about transmitters except power applies to receivers as well.

First, antennas were erected solely with the idea that the more wire and the higher the wire, the better. No thought was given to feed line because the antenna was grounded and a part of the transmitter circuit anyway; however, with the coming of the "short" waves, it became apparent that the best antenna was a half-wave as high as possible. Of course, the grounded vertical was and still is used, but the half-wire horizontal antenna had to have a feedline. Height had some influence, but was not deemed important.

Right away, it seemed, an argument began:

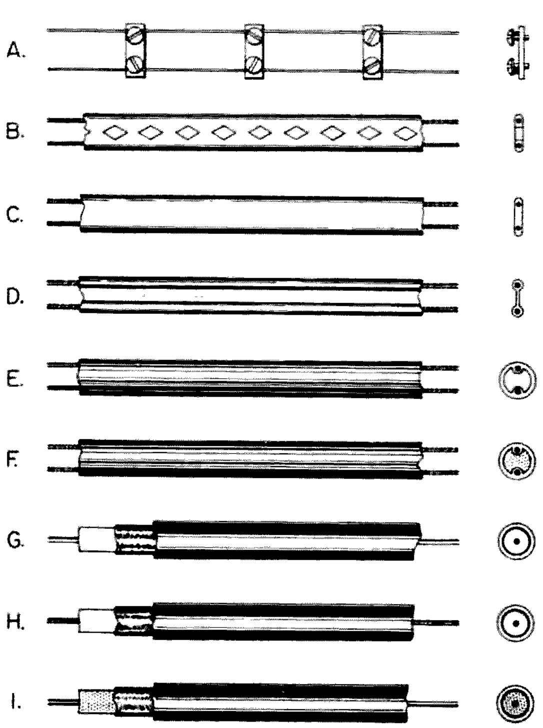


Fig. 1. Common types of feedline.

Which was better—end feed or center feed? Also, what was the proper "impedance" of the line? The impedance didn't really matter to amateurs, but the feed point did. If you fed at the end, you needed only two supports for the wire, one at either end; but if you fed in the middle, *three* supports were usually needed, one in the middle to hold up the feedline. The feedline was the same for both.

It was the so-called "ladder line" (**Fig. 1a**) of two wires held apart by spacers. The impedance was often given as "600 ohms," but nobody cared very much. "Standing waves," if thought of at all, were expected and even encouraged. Everyone had an antenna tuner with variable coupling to the transmitter.

The "center feed" side had the best of the argument, it seemed. No matter what frequency was put out, the feedline was always "balanced"; the voltage and current in one wire always canceled out the voltage and current in the other wire. Result—no feedline radiation. This was not true of end-feed where feedline radiation occurred whenever the antenna itself was not exactly a half-wave or multiple of a half-wave long. You rarely hear of an end-fed half-wave these days.

Just before WW-2, somebody discovered that a half-wave horizontal wire (dipole) could be fed with ordinary twisted lamp cord. It was lousy when wet, but was easier than building a feedline. It wouldn't handle a kilowatt either. The manufacturers brought out EO-1 cable, which wasn't very good, but was much better than the lamp cord it replaced; it was the first generally available low-cost, low-impedance feedline.

Then came the War and polyethylene. It and the war-surplus made low-cost feedlines available to everybody, and the arguments started, growing with each new development in feedlines. Today we have lots of lines available, thanks to polyethylene and to TV. See **Fig 1**. We have.

a. Ladder-line, two wires held separated by spacers.
b. "Punched" line, a ribbon type with a

portion of the polyethylene removed.

c. Ribbon line, of solid polyethylene.
d. "Dumbbell" line, with the insulation thinned to make it cheaper.
e. Tubular line, to reduce the effect of rain.
f. "Foamed" line, lower losses than the tubular.
g. Solid inner conductor coax.
h. Stranded inner conductor coax.
i. "Foamed" coax with less insulation than standard.

The ribbon types we owe to TV and is nearly always 300 ohms. The coax is either about 75 ohm or 50 ohm impedance.

All insulation has dielectric losses, and while polyethylene is good, some kinds have losses that are higher. With air as 1, solid polyethylene (as in the coax type) has a figure of about 2.6 and the nitrogen foamed variety about 1.7. In contrast, the ladder type line has a figure of 1.01 or better. Air is the ideal.

The losses in db per 100 feet increase with the frequency and the amount of insulation. For the lower bands, as 75 meters, it will make very little difference *what* kind of line is used, but on 2 meters it will pay to study the loss figures very carefully. It is very easy to lose three-fourths of your power in the feedline on two meters!

Power-handling capability varies greatly with the type of line in use. It has nothing to do with db loss, but increases with the size of the conductors and the impedance of the line. Always remember that a given line will handle less and less power as the SWR goes up because it is the SWR that determines the maximum current on your line, and the line will handle no more current than the smallest of the conductors can handle without melting or distorting the insulation. A line may be "good" for 500 watts only with a 1:1 SWR.

The SWR on a line increases losses in db, but it is only of importance if the db loss of the line is already high or if it exceeds the wattage rating of the line; otherwise, the SWR on the feedline is of little, if any, importance. If the antenna takes the power, it will radiate it no matter *what* the SWR is.

Nor is the impedance of a line of very great importance except it should match the antenna. These days it is possible in some way to match an antenna to almost any line available. Of course, nearly all manufactured and kit-form transmitters are built to "match" 50 ohm coax. This is the cause of the argument.

A "balanced" antenna—dipole, yagi, quad, rhombic, etc.—requires a balanced line, as ladder line or ribbon. An unbalanced antenna—grounded vertical, groundplane, coaxial skirt

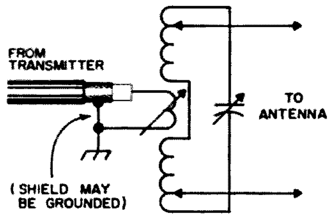


Fig. 2. Antenna matcher.

—requires a coax line. Transmitters nearly all require coax.

What is the best type of line? The "ladder" type. With proper type separators, it has negligible loss, is practically unaffected by the weather, standing waves do not bother it, and, being air-cooled, can handle much higher power for a given wire gauge. There are a few drawbacks. The impedance is high, usually 300 ohms or more, and commercial varieties often have plastic separators that become very brittle when exposed to light of the sun. With all types of balanced line, it is necessary to keep the wires of equal length and spacing, several inches at least, away from all conducting objects, and make all turns gradual.

Next to the ladder type line in desirability is the round nitrogen foamed line, then the round tubular line. Both are relatively unaffected by wet weather, with the foam type giving the lowest loss. As with all polyethylene insulated lines, the power and/or standing waves must be kept down to keep from melting the insulation. The flat, or ribbon, lines are the worst (and cheapest) types, very much affected by rain. If you must use polyethylene, be very sure you get the type with an ultraviolet inhibitor that prevents the development of brittleness when exposed to sunlight.

For coax line, be sure it has virgin polyethylene insulation, white or clear, not brown. It needs no additives against ultraviolet or sunshine, being covered. Stranded wire is best for the center conductor in the interest of flexibility. The shield braid should be tight, covering 95% of the polyethylene. The neoprene coating should be of the best, with no plasticizers that will "bleed" into the center insulation in hot weather. Lastly, the nitrogen foamed line is much the best. If you can, inspect a sample. If the different layers stick together, it is old and of poor quality. The impedance, of couse, should be of the proper value.

The big question is, of couse, "How do you connect a balanced dipole to an unbalanced transmitter?" The answer is, "You must use some sort of matching device." The common-

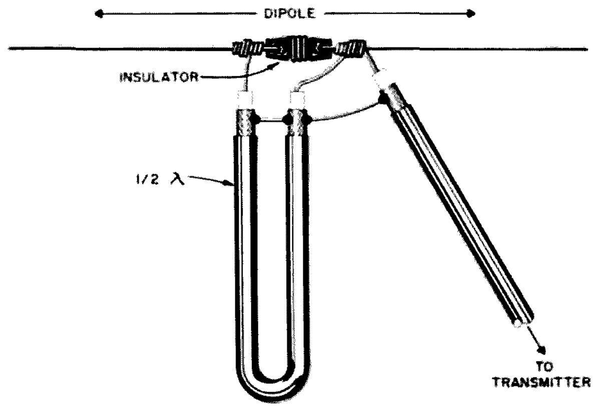


Fig. 3. Coax balun for matching coax to a dipole.

est is either an antenna tuner or a balun. **Fig. 2** shows the circuit of a typical antenna tuner. If you do *not* use a matching circuit, regardless of the impedance, the shield of your coax will pick up a voltage equal to the center. The center cannot radiate, but the shield can and does. This is the reason coax cannot be recommended for balanced type antennas. The radiation can, and sometimes does, "back-up" on the transmitter chassis and the AC line to cause feedback and TVI.

Parallel wire line will radiate whenever the voltage and current in one wire is not exactly equal and opposite to the voltage and current in the other wire. This can come about through unbalanced feed from the antenna ("Windom" antenna, etc.) where the feedline wires are not the same length, or when one wire runs closer to a conductor than the other. When one wire is grounded at the transmitter (a common case), the balanced feed will put rf on the chassis unless the transmitter ground is a true rf ground, which is almost impossible. The result is a likelihood of feedback at the microphone and/or radiation (and TVI) from the power line. Of course, troubles from radiation increase with frequency.

TV producers long ago found out about coax. For years now all TV beams have been of the balanced line type (300), with a wideband balum transformer to line-type feed to the unbalanced input of the receiver. (Incidentally, these balums will handle low power very well for 2 and 6 meters.)

The antenna turner has the advantage of responding only to one frequency, effectively reducing harmonics. It is unaffected by SWR and feedline impedance, and it will reduce the SWR on the coax to 1:1. (If it does not, the excessive SWR is the harmonic content of the transmitter.) It has its drawbacks, though. It adds two or more controls to the transmitter. It is essentially, even with plug-in coils, a one-band device. (But so is a good antenna.) It really cannot do anything about antenna mismatch and SWR on the feedline.

Coax, such as RG 8/U, can be run anywhere that the insulation will stand, such as inside walls, through pipe, under ground, etc. It will match nearly every transmitter. It is what nearly all SWR meters are built for. With a proper balun it will couple to most antennas. And it will handle a fair amount of power. But it has a pretty high loss at high frequencies and if not balanced, will radiate from the shield.

A ½ wave feedline balun (see **Fig. 3**) is a good device, but only good close to one frequency. It has a 4 to 1 ratio, matching a 300 ohm antenna to an unbalanced 50 ohm feedline. The popular "Gamma" match is good for matching an unbalanced line to a dipole only when the antenna's "neutral point" is thoroughly grounded for rf; otherwise, the shield of the feedline will radiate. Other types of match, such as delta, tee, stub, etc. will radiate from the shild, particularly on harmonics.

On the lower bands, losses in feedlines do not matter so much, but harmonic radiation does. An antenna tuner is the answer. On the high frequencies, a ladder line and tuner can give you three db or more signal. It seems a cheap way of doubling your power.

If you bought your antenna ready made and it calls for coax feedline, obey your instructions. Maybe it was built to use that line and that impedance. If you feel adventuresome or like to build your own, consider the ladder-type line and an antenna tuner. It will practically eliminate harmonics, laugh at any SWR, and reduce losses. Just be sure the wires are of identical length, have no sharp bends, and are evenly and closely spaced. The nitrogen foamed parallel line is almost as good, but has more loss and will not handle the power.

Coax line should be used with some sort of a balun. The ½ wave balun of **Fig. 3** discriminates somewhat again harmonics as well as balancing the feedline output. There is little to be gained by cutting a coax to a certain length for better feed. If it works, the SWR is too high anyway. Coax is a good type of feedline within its limits—short lengths, or low frequencies, with some balancing system to keep the shield "cold", and low SWR—and it matches nearly all transmitters.

I hope the statements in this article will, perhaps, put a few more watts on the air and reduce a few SWR's *and* add fuel to the FEEDLINE ARGUMENT. . . . WØOPA

Letter from Jail

Wobblywire, Wisc.

Dear John:

You FCC fellers have troubles, but let me tell you about mine.

Recently I was mobiling leisurely alongside Lake Snagg at 65 as everyone does, when a crosswind blew my mobile logbook out the window and into the lake. I stopped immediately, as did none of the 13 other cars behind me in my lane. I shouldn't call it "my" lane, but after all the left lane is for passing and I really did intend to pass anyone I might overtake in my V.W.

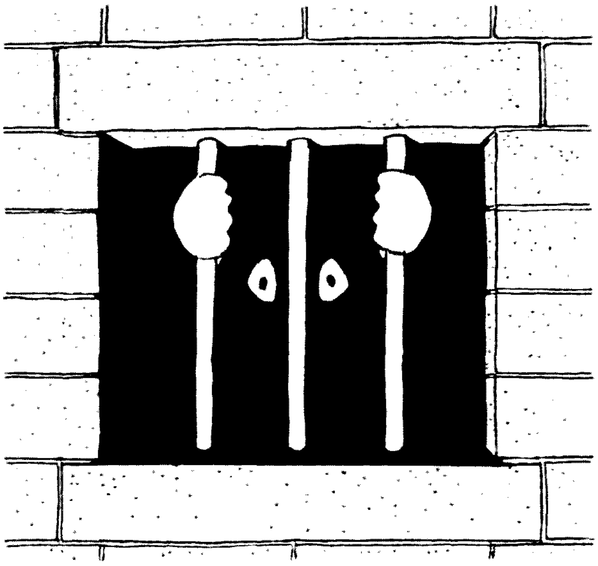
Remember those stink-bugs that put their heads down and their rear ends up when you touch them with a stick? Well, that is what those cars behind me did. Their front ends tried to kiss the pavement and their rear ends went up. It doesn't take an Einstein to figure out what happened as all 14 of these bugs were moving at 65 except the first one, which was stopped.

There was now no moving traffic, so I

pulled into the vacant right lane, stopped, and ran to the lake just in time to see an "eager" beaver grab my log and start to swim away with it. Horrors!! To retain my log for one year I must somehow scare him into releasing it. I threw at him the only thing available, my portable receiver, tuned to the local Jaybird Net. Those with strong stomachs and weak minds can stand this net, but Mr. Beaver had neither. He released the log when the blaring receiver went whizzing by.

What followed was a bit exciting. After the receiver hit the water there was a dandy explosion, caused, Im' told, by the mercury cells. At any rate, my log soon came ashore amid the waves. Drippy logbook in hand, I returned to my car, checked back into the net, and was starting to tell the gang what had happened when some irate clod in the adjacent lane yelled a comment of such amplitude and color it was transmitted at least Q5. Then the patrolman arrested me.

John, I am now in the local Bastile. Let me tell you their ridiculous charges:



(1) "Driving in the wrong lane." I thought it was the left lane. Can you imagine signs reading "Wrong Lane for Passing Only," or "Keep Right, Pass Wrong?"

(2) "Leaving the scene of an accident." What accident?

(3) "Reckless driving." This should be "Wreckless driving," as I was the only one of the 14 who did not have a real wreck.

(4) "Failure to park off roadway." Did they expect me to park in the lake?

(5) "Blasting for fish." Nowhere in the law does it prohibit blasting for logbooks.

(6) "Killing beaver." Mr. B. started this fracas, should suffer the consequences, and did.

Johnny, my old pal, I have another problem. What that idiot yelled was transmitted by my rig, and it obviously was not under my control. As I see it, I have several alternatives:

(1) When my logbook dries out, enter in it the remark in code, so if you birds ever try to nail me for this I'll be ready.

(2) Send a description of the incident, including the remark, to you at the FCC. I could run afoul of the Postal regulations, and a number of FCC girls would handle this letter before it reached you.

(3) Forget the whole thing, and trust you will do the same.

I remain,

Ken W6GTG/9/jail

P.S. You have a paragraph 97.105, "Retention of Logs," and a 97.107, "Operation in Emergencies." As there is no 97.106, possibly you could add one, "Retention of Logs in Emergencies," to cover logs lost to beavers, used for lighting fires, for smoking Bull Durham, as coloring books, flushed down drains, etc. Please!

Ham Ordered to Dismantle Tower

Wm. E. Hough, Jr., of E. Hemfield Township, Penna (call unknown) was recently ordered by the Penna. State Supreme Court to dismantle his 54-ft tower and antenna. Mr. Hough had appealed a ruling by a local judge "that the antenna structure violated the deed restrictions to the Hough home." Mr. Hough stated that he moved into this development area in 1959 after being assured by a real estate agent that no restrictions were made regarding such a tower.

The suit was brought by the owners and developers of the real estate development upon "repeated complaints by neighbors".

The Court's opinion, written by the State's Chief Justice, said in part "it is clear that such a tower with or without the antenna on top does not fall within the permissive structures that could be built on this lot—"

According to the *Daily Intelligence Journal* —Lancaster, Pa. of Jan. 6, 1966, "this was the first case involving deed restrictions affecting ham operators to reach the highest court in any state and will probably serve as a precedent, reports indicate."

IoAr just learned of this suit and the State Supreme Court's decision as we were closing copy for March 73. Further news—as soon as available, direct from Mr. Hough.

IoAR and 73 is indebted to Mr. Ronald L. Herr, Annville, Pa. for alerting us to this momentous court decision.

Get out *your* deed and read the *fine print*!

. . . W7ZC

Historical Note

Ray Thrower WA6PZR

Old timers will remember Phil Spitalney and his All Girl Orchestra, with Evelyn and her Magic Violin. This musical group was quite popular in the late 1930's and early 1940's and made a number of the then popular one night stand tours across the country. Accordingly, the girls traveled in a group of chartered buses.

Old timers may also remember that a number of the gals in the group were radio amateurs. Of course travelling as they did all over the country, it was only natural that the girls installed a mobile station in the rear of one of the buses.

It was really an advanced "state of the art" installation, even by today's standards. It contained a number of receiver/transmitter positions operating on several different frequencies.

While there was plenty of room in the rear of the bus for the transmitters, receivers and power supplies, the girls were still confronted by that nemesis of all mobile installations, the antenna.

Considerable intensive research and effort was invested by these female Marconi's to develop an antenna or antennas that would serve in the mobile service and that would resonate on a multitude of frequencies without having to stop the bus and change taps on the loading coil, etc.

Eventually this research paid off. An antenna was developed and proven that had all the desirable characteristics of a mobile antenna. It was compact. It was esthetically acceptable to the most critical individual. And, it had gain! A minimum of three db at its low range of 2 mc and a maximum of twelve db at its high range in the old 5 meter band!

Note that this was continuous coverage—2 thru 60 mc!!! This then was the first, true Broad Band Antenna. . . . WA6PZR

John Fuhrmon KØLFA
1526 Que Street
Lincoln, Nebraska

Improving the HX-20, HR-20 and HP-20

Sometime ago, I purchased the HR-20 receiver, HP-20 power supply and HX-20 transmitter. On-the-air reports were very satisfying concerning the quality of the transmitted signal. The receiver's performance compared very favorably with my old station receiver, which was a $250 commercially wired unit.

However, the units have acquired many changes or modifications over the months. Most were to improve on factory specifications or to satisfy my own operation needs. While many amateurs may not want to include the more extensive and difficult modifications, some might find the easier changes may improve their operating pleasure.

The HX-20 VFO was surprisingly stable for a unit built from a kit. However, as the manual stated, the warm-up drift was at least 500 cps or more. Unfortunately, until the unit had been on twenty minutes, the vfo moved across the dial causing many complaints from other stations. For many amateurs this small drift doesn't seem unreasonable but since I must take my operating as I find time, the drift was intolerable.

Upon the completion of a few cut-and-try ventures, the last ditch cure was decided upon: differential temperature compensation.

Many different circuits were built and tried on paper until the final form was developed. The circuit and values are shown in **Fig. 1.** All of the values were calculated to provide a wide enough adjustment of the drift co-efficient to allow for tube and component aging.

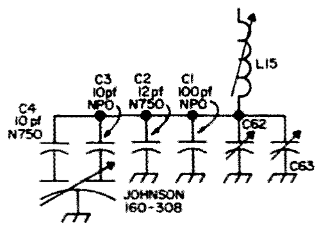


Fig. 1. Addition of a differential capacitor to the VFO to reduce drift.

The differential capacitor is a Johnson #160-308 which is variable from 2.3 to 14.1 pf. It was installed behind the VFO capacitor.

After installation, set the differential capacitor at mid-range and re-set dial calibration using only C62. Allow the new circuit to age for at least twenty hours or normal operation. This will insure "baking-in" of the new circuit.

Exact stability will require a very stable source and scope. I used a 100 kc evacuated crystal standard after a three hour warm-up. The scope's internal horizontal sweep generator was calibrated using the 60 cps test source connected to the vertical input. One sine wave displayed represented a 60 cps sweep rate; two sine waves indicated a 30 cps sweep rate; three sine waves for a 20 cps sweep rate; etc. likewise a 30 cps input will produce one sine wave at 30 cps sweep or two sine waves at 15 cps sweep.

A little experimentation will reveal how easy it is to determine which way the drift is and its approximate rate with respect to time if the simple test set-up in **Fig. 2** is used. I found many times that I could *see* the drift before I could even hear it!

Of course all adjustments must be made with the HX-20 in its case. Luckily there is a mounting hole almost directly over the differential capacitor shaft. Since the differential capacitor is not perfect, its adjustment will introduce some dial error that can easily be corrected by C62.

(In the following paragraphs any reference to vfo drift is made at its operating range of 5.0 to 5.5 mc, not the output ranges of the HX-20 (4.0 mc output = 5.0 mc VFO frequency).)

The position of the N750 capacitors is very important. The rate at which they receive heat from the 6AU6 socket and components is the secret to a low warm-up drift. A movement of ⅛" will have an effect on their drift rates with respect to time. For example, if the vfo drifts down for the first hour and then drifts higher, move C2 (12 pf-N750) closer

to the tube socket.

Before starting any real stability tests, I would like to insert a word of experience: the complete job will require several days and should *not* be done on the kitchen table unless an ample supply of TV dinners are on hand.

Always allow five minutes after any adjustments of the variable capacitors before starting any drift measurements. Their resistance to movement causes them to drift about 50-60 cps back towards their previous settings. A five minute wait will allow them to set-in. All drift measurements should be made from a cold start on upper side band. (The 14 mc LSB crystal drifts aproximately 60 cps from a cold start.)

If the vfo drifts down and becomes stable, rotate the differential capacitor rotor further into mesh with the stator plates connected to C4 (10 pf-N750). If the vfo drifts up, rotate the rotor of the differential capacitor farther into mesh with the stator plates connected to C3 (10 pf-NPO).

If drift cannot be controlled at either extreme of the differential capacitor, increase or decrease the size of C2 (12 pf-N750) as dictated by which extreme the differential capacitor is set at. (The characteristic must still be (N750/C.)

This circuit is easily capable of a 100 cps stability from a five minute warm-up. After one hour the heterodyne crystals in the HX-20 were the primary cause of the remaining drift.

Mechanical instability of the vfo can be improved by a couple of drops of hot candle wax into the center of L15 after final dial calibration. Encapsulating all of the components around the 6AU6 socket with "Q-dope" removed all traces of mechanical instability in my unit.

Operation of the HX-20 and the HR-20 on the 20, 15, and 10 meter bands disclosed a few cycles of drift in the HR-20 between transmissions. Examination of the problem revealed the frequency change was due to the removal of B+ from the HR-20 during each transmission. This slight drift was eliminated by shorting pins 1 and 2 of the VOX relay at the rear panel by connecting pin #3 of J3 in the HX-20. This change left the HR-20 receiver operating all the time, which necessitated a few changes in the receiver to be discussed later. The continuous operation of the HR-20 causes a slight overload on the HP-20 power supply during transmissions, but after one year of operation no component failures have occurred. The plate voltage on the 6146 is still over 600 volts at full load

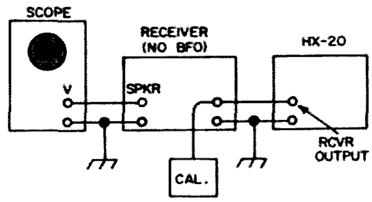


Fig. 2. Adjusting the differential capacitor.

and no noticeable variations in output accompanied this change.

Since most of my operation is on the lower frequency bands, the receiver injection voltage divider at the grid of the 6146 was changed to provide a higher level signal for zeroing. R69 (1000 ohm) was changed to 1 megohm. For this change a pigtail splice is recommended. The very limited space available in the 6146 compartment would increase the chances for component damage if a complete change-out were attempted.

Unfortunately, after this change, a small amount of rectifier hash from the linear was introduced on 20, 15 and 10 meters. However, when I operate these bands, I unplug the receiver from the HX-20 and use the linear's antenna relay. The signal leak through is still adequate for zeroing.

I was unable to obtain full scale deflection of the output meter on ten meters until I replaced R-79 (2000 ohm) with a 20 µh rf choke. Not only was the meter sensitivity improved but smaller amounts of carrier could be used for tune-up, thereby decreasing the chances for tube damage due to out resonance operation during tune-up. The extra meter sensitivity also showed me that I had poorly aligned one of the traps in the 6AW8 mixer stage.

For the proper setting of the carrier crystal on the slope of the crystal filter, I used another receiver and "moved" the crystal around until the sideband quality and unwanted sideband suppression suited me. After doing this the carrier rejection was very poor and the carrier null potentiometer was rotated to one end of its range. Several ideas were tried in an effort to find a way to suppress the carrier without disturbing the carrier crystal frequency. The end result was changing R17 (200 ohm) to 380 ohm. This seemed to be the best and simplest solution. Several tests, on the air and into a dummy load revealed the carrier rejection to be as good as or better than the sideband suppression. On the air reports were obtained while driving a 500 watt linear.

While setting up the combination to drive my linear in a permanent location, severe problems were encountered in the voice control circuits. The HX-20 would cycle wildly

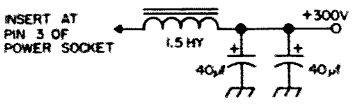


Fig. 3. Additions to the HP-20 power supply.

or hang-up after each transmission as long as the linear was used.

My antenna relay control voltage is derived internally from the linear and tests revealed rf on the control line as the cause. By-passing each side of P2, the external relay control plug, with .01 µf disc ceramic capacitors ended all difficulties.

After adding the shorting jumper in the HX-20 to leave the B+ applied to the HR-20 during transmissions a few changes had to be made to allow for audio output transformer protection and avc overloading.

The first transmission after installing the jumper in the HX-20 was accompanied by a rattle from the audio output transformer of the HR-20. A little searching revealed that although the eight ohm output was grounded during transmission, a voltage was being developed between the grounded 8 ohm tap and the 500 ohm output. Rather than extensively re-wire the HX-20 control relay, a 1000 ohm ½ watt resistor was added from the 500 ohm tap to ground at the headphone jack in the HR-20 (J3—the white lead is the 500 ohm connection). This load did not upset the audio level or anti-vox gain and, in my case, improved the HX-20's ability to withstand static crashes without tripping.

With the receiver operating during transmissions, the avc on "slow" was almost useless because of the long discharge time before enough gain was restored for normal copy. To make the slow avc usable on SSB again, the slow avc capacitor, C57 (0.5 µf) was changed to a 0.25 µf/200 v Mallory PFC Mylar type. I used the Mylar type because of its smaller size.

The very high gain of the 6EB8 triode-pentode combination was really a blessing in disguise. Without a load or at full gain the stage was so hot that it oscillated or "rang" from regeneration. Unfortunately, this extra gain also caused transients to be introduced to an extent that operator fatigue was noticeable.

To put this extra gain to work for me, 15 db of negative feedback was added.

I connected a 560K resistor and .01 µf capacitor in series from pin 1 to pin 9 of the 6EB8. This addition relieved the transient responses and regeneration tendencies.

In my opinion, any station worth its call letters should have an independent signal standard for dial calibration and alignment purposes. Because no provisions had been included for a 100 kc standard inside the HR-20, I modified the Heath HRA-10-1 100 kc Crystal Calibrator for use with the HR-20 receiver.

The HRA-10-1 was assembled according to the manual, except that the bottom plate with the octal plug was discarded and a solid blank was made to replace it. All of the power and output voltages were carried using three conductor cables, one conductor shielded. The shielded conductor was used to carry the output to the antenna terminal, J2. Heater and B+ were carried on the other two conductors.

The unit was mounted to the rear of the 3 kc bandpass filter. The 6-32 hardware was removed from the internal chassis shield and replaced with a metal screw into the side of the HRA-10-1 case after drilling a pilot hole in the HRA-10-1. A quarter inch hole was drilled through both chassis to pass the power cable. A ⅛" hole was drilled in the chassis base center section to pass the shielded output lead to the antenna input, J2. The heater lead was connected to the heater off-on switch at the back of the volume control (this lug has a brown lead from the cable clamp on it). The B+ was carried to the inside of the product detector shield.

The SPDT sideband crystal selector switch was replaced with a DP-4 position, 30° detent rotary switch. The B+ lead to the control switch was run in from lug 1 of terminal strip F. Since this unit was wired for 12 volt operation, the 6BA6 was replaced with a 12BA6.

This arrangement provided me with upper-lower sideband plus calibrator by simply rotating the sideband selector switch one position past the old stops.

The 3 mc crystal band-pass filter *if* frequency allows centering the calibrator signal in the passband by listening to the heterodyne between the 3 mc leak through and the desired 100 kc harmonic of the calibrator if the AM detector is used.

To further reduce hum on the suppressed carrier and the receiver audio, the three hundred volt supply filter was modified to include a 1.5 hy @ 200 ma choke and two 40 µf @ 450 v dc electrolytic capacitors (**Fig. 3**). The choke was added by moving the bleeder resistor to one side while the two electrolytics were placed over the other two 40 µf @ 450 v dc capacitors already in place on the under side of the chassis. While the change was undetectable to many observers, the local operators were able to notice the difference.

. . . KØLFA

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The Walky-Nosy

If you have ever done any emergency communications work in a local two meter net, you have probably wished for a small, compact battery operated receiver with which you could monitor net activities while you covered your duty area.

And perhaps you have also wished for a means of tying your own emergency contributions in with the local police department or other local authorities such as fire and public safety operators.

The receiver-conversion suggested here will solve this problem for you, and give many additional surprises.

Like many ardent VHF enthusiasts, I was curious aobut the high-end receiving capabilities of the many Japanese FM portable radios. A dozen or more U. S. importers have flooded the U. S. market with 9 to 11 transistor FM and AM/FM battery operated-hand carried portables. These units vary in design detail, but all follow a basic format. They cover the 88-108 megacycle FM range; have a transistor RF stage, two or three stages of *if* and some method of FM detection that varies from slope detection with a standard AM detector circuit to a quadreture coil arrangement for pure FM detection.

You will find these little import sets at the nearby Lafayette store, the corner drug store and the local camera shop not to mention the chain discount stores. Prices vary from $20.00 to $40.00.

These receivers fall into two broad categories. Those which can be easily converted to high band (115-165 mc) reception, and those which cannot—easily. Those which cannot be easily converted are easy to spot; they feature a sealed front end-mixer-oscillator arrangement all neatly packaged up in a small plastic container. The top of the container is always studded with four to six small screws, which in reality are adjustable capacitors in the various RF, mixer and oscillator circuits. Stay away from this type of receiver for conversion possibilities, unless you are prepared to tackle the dismantling of the small plastic sealed box (not recommended!)

The convertible type are equally easy to recognize. The RF amplifier circuit (with coil), mixer and oscillator circuits (with coils) are all out in the open.

The only work you will need to de to convert such a unit to tune any 20 mc segment between 115 and 165 is to raise the operating frequency of the RF amplifier circuit, the mixer circuit and the oscillator circuit.

Conversion

Our "case conversion" will be around a commonly available import, the Claricon model 46-045 AM/FM portable receiver.

The procedures outlined for this receiver have been successfully adapted to a number of other import units, such as the Lloyds TF-911 series set.

We have converted nearly a dozen Claricon sets to everything from aircraft (115-135 mc)

to fire and police (155-165) and can recommend this model completely for ease of conversion and stability of operation after conversion.

The Claricon model 46-045 operates from four type "AA" penlight cells, 6 volts dc total. Current drain is sufficiently low that one set of batteries has run as long as 8 hours a day for two months on the local police frequency without signs of voltage degradation.

This unit has a 10.7 mc *if* (three stages no less), adjustable discriminator circuit, built-in 27 inch whip, carrying handle and earphone with jack.

First open the back of the case and identify the conversion components: the antenna coil, RF amplifier coil and oscillator coil.

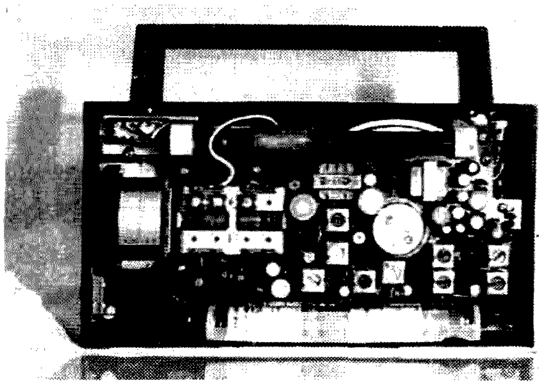
The RF amplifier transistor has a multiple turn antenna coil at the base of the 27 inch antenna. This coil is a 3½ turn airwound coil ⅛th inch in diameter.

Table one shows that to convert this circuit to 150 mc operation is will be necessary to reduce this coil to 1½ turns overall. You can reach 1½ turns overall by shorting the three full turns together, to form a single turn.

(NOTE: the 150 megacycle region will probably be the most common conversion because this region contains the frequently utilized police, fire, public safety and business radio services.)

Next stop is the FM rf coil. This, in the Claricon receiver, is the 5 turn center tapped ¼th inch airwound form. One turn must be removed from each side of this center tapped coil. If you choose to merely short two turns together to lower the inductance of the coil, use a very fine file or emery board to clean the protective coating from the turns before soldering.

Last stop is the FM oscillator circuit. This is a four turn coil on a 5/16's form, mounted upright on the circuit board just to the right



Here's the inside of a typical AM-FM portable receiver. The gang variable capacitor can be seen at the upper left with the rf coils below it.

	Coil Information		
Antenna Coil	RF Coil*	Oscillator Coil	Peak Receiver Frequency
1½ t.	3 t.	3 t.	160 mc
1½ t.	3 t. ***	3 t. **	150 mc
2¼ t.	3¼ t.	3¼ t.	140 mc
3 t.	3½ t.	3½ t.	130 mc
4 t.	4 t.	3¾ t.	115 mc

* — Center-tapped coil (coil information is for total turns, with tap in center

** — Re-tune oscillator slug from peak 160 mc reception

*** — Re-peak trimmer mixer section padder from 160 mc setting

of the gang variable (looking at the receiver from the back and bottom, as shown in the photo).

A 60 pf condenser ties the top of this oscillator coil to the variable capacitor, tuning the oscillator over the appropriate frequency range. Exactly one turn from this coil *(taken from the top end)* will move the oscillator tuning range upwards to approximately 140-150 mc.

A small trimmer across the oscillator section of the variable capacitor will pull the center oscillator range over approximately an eight mc range (plus or minus 4 mc). Using a non-metallic tool, turning the trimmer clockwise lowers the oscillator frequency while rotation counter-clockwise raises the oscillator frequency.

Tune up procedure for the converted receiver will probably take longer than the conversion mechanics.

If you live in a population center, there will be many high band signals on the air for tune-up purposes. With the back off the receiver, but the telescopic antenna extended and the antenna lead-in wire inserted in its jack, tune up may begin.

The oscillator should be turned clockwise as far to the right as its will go, without applying any pressure to the slug in the tightening process.

Now look for a small padder variable across the mixer section of the variable gang capacitor located at the top left of the variable.

Using a non-metallic tool, tighten this variable clockwise to the right also, until it comes to a stop.

Turn the receiver on and with the dial set in the mid-region (i.e. approximately 100 mc on the FM dial) advance the oscillator slug counter clockwise by ¼ turn.

Now return to the mixer trimmer and advance it counter clockwise very slowly listening to the rush of background noise coming from the speaker. You should be able to detect a slight but noticeable increase in background noise very shortly after you start counter clockwise rotation. If you do not notice a rise in noise, set the padder approximately 20% of one turn counter clockwise from stop and leave it for now.

Return to the oscillator slug. Using the non-metallic tool once again, rotate further counter clockwise very slowly. At some point between ¼th turn from stop and ¾ turn from stop you will begin to hear a multitude of off-the-air signals. Note the range through which you can swing the slug and hear the signals, and then set this control to the mid-point of this range.

Now return to the mixer trimmer and touch up the tuning of this padder by picking a weak signal in the middle of the dial, and tuning for maximum signal.

At this point you have a fully converted hand carried police, fire, aircraft (or whatever) receiver suitable for metropolitan area use anywhere in the United States.

You may wish to touch up the tuning of the adjustable discriminator, and to do so you merely insert a non-metallic tool into the pink colored slug tuned *if type* can on the right hand edge of the receiver, and tune for best audio.

Results

With the converted receiver sitting in the seat beside us in the car and the earphone in our ear it is painless to copy the local 250 watt 155 mc police dispatcher 6 to 10 miles away. And this is with my portable receiver and antenna completely encased by the metal body of the car!

Background noise is very low under no signal conditions, so this unit also makes an excellent (although unsquelched) base receiver for home or office reception of local high band calls.

Because the unit is designed around a true quadreture coil FM discriminator, you would *not* expect it to respond to AM signals, such as you find in the aircraft services between 108 and 135 megacycles and the 2 meter band. Not true. Aircraft reception is especially good, as witnessed by my consistent (although slightly noisy reception of Sacramento, California approach control over 90 miles to the north, using just the simple 27 inch whip antenna on my workbench.

Someday, perhaps soon, an enterprising Japanese manufacturer will design and import to the United States a high band receiver for the business and casual listener. Until he does, however, you like me will receive many hours of enjoyable (and downright fascinating) high band listening wherever you go with a converted FM portable receiver, as outlined here.

. . . K6EDX

Ken Cole W7IDF
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Vashon, Wash.
Drawing by K3SUK

Our Friend, The R.I.

Upward and onward with the FCC

"The Eyes of Texas Are Upon You" may remind Congressmen of L.B.J.—to me it means G.B. and a memorable conversation with a ham.

His name was Guzz Brewer W5DAA, and seven days later a QSL arrived confirming our ten meter contact. On the eighth day I received an official notice from the Kingsville, Texas monitoring station also reporting reception of W7IDF. On 21012 kcs. At that time the fifteen meter band had not yet been assigned to the amateur service, and this second communication from Guzz was signed: "Henry L. Brewer, Inspector."

That was a bad day, but the coincidence emphasized the warning, and I like to think that it is partly due to having met Guzz and Henry Brewer almost simultaneously that I've managed over the years to keep my spurious emissions to an acceptable minimum.

In my QSL file W5DAA's card is stapled to the official notice, and when I came across it the other day it occurred to me that our hobby would be in a far worse mess than it is if our governing authority were not dealing conscientiously with an onerous and thankless task. One thought led to another until I was left with the conclusion that, as an average ham, I knew too little about the Federal Communications Commission. This is a deplorable situation, and rather difficult to understand, for in other areas of regulated activity the subject citizens generally know quite a bit about the authority under whose jurisdiction they operate. The policies and plans of commissions and agencies such as the ICC, SEC, AEC and FAA are subject to constant appraisal, analysis and criticism by the interested public. Even the reputed views and personal inclinations of the influential officers are examined by hard-nosed reporters and rather less objective lobbyists. But with respect to the salient workings of the FCC only the interests of commercial communication and broadcast are served by probing trade journals and newsletters. Newton Minow apart—and I salute his audacity—the lively art of public relations has been neglected by the FCC. The amateur community in turn largely ignores the Commission, except when taking sides on specific issues. The ARRL is familiar with Commission headquarters, but like a good gray night watchman making unobtrusive rounds with an eye for trouble, voiceless except to cry alarms. Consequently a quarter of a million hams are pretty much in the dark about the arm of

government assigned to manage our affairs.

I think this is regrettable for a number of reasons, and the least of these is the perennial pressure on the FCC to relieve us of some of our frequencies. Ultimately it is the efficiency of the Commission in doing its job that determines the true value of the allocations we hold, as well as those set aside for the broadcast, industrial, safety and other services. I would suppose the efficiency of the FCC depends on the funds appropriated to it, the staff and the size of the job. Well, if you investigate these factors you will find what seems to me to be a curious state of affairs.

Let's go back a bit for a starting point. Not long before the second World War I struggled through the examination for my first ham ticket in the Seattle headquarters of the Fourteenth District. The Commission offices occupied a corner of the top floor of the Federal Office Building, and the staff included four engineers and three clerical assistants. Today, well into what we may as well call the Electronic Age, the transmitters in the United States total 1,475,434—twenty two times as many as there were in 1940. A proliferation of inventions has resulted in new modes, new problems and stricter operating tolerances; in general a difficult job has been made almost impossible and the future promises more of the same. In the Commission's Fourteenth District the federal government has met this challenge head-on by not cutting down on the size of the staff employed here a quarter of a century ago, and the very modest office space has not been reduced. Indeed, during visits to renew amateur and commercial licenses I have noticed very few changes. Knowledgeable, friendly and harassed Engineer-in-Charge L. C. Herndon has been superseded by knowledgeable, friendly and harassed Engineer-in-Charge Herbert Arlowe, and the view from the top floor gradually is being lost to the rising skyline of the city.

My experience with the FCC has been limited to the Seattle office, but the national picture is more important so let's take a look at it, remembering that in 1940 life in the world of wireless was simple; tried-and-tested modes were the rule and there were less than 68,000 stations on the air in all services. The Commission did the job then with 625 employees, although they could have used more. Today, twenty five years later, there are 1,498. In 1940 the Commission was given $1,838,175; in 1965, $16,985,000. Another way of saying it—and I can think of a third way—is that to cope with twenty two times as many stations and the headaches of a technological revolu-

tion the FCC is allowed less than ten times the 1940 appropriation, and it's paid in smaller dollars. The "user fees" inaugurated recently by the FCC will aid but will not defray a significant percentage of the overhead. As for the hired help, today the Commission has 2.4 employees for each one on the rolls a quarter of a century ago.

Incidentally, the FAA also has proposed "user fees" to help pay the bill, and this reminds me that this year the FAA will be employing slightly more than 46,000 people—about thirty times as many as the FCC. The FAA appropriation of $751,250,000 is nearly forty five times the Commission budget. Invidious comparisons are usually unfair or set up with some mischief in mind, but the purpose of this one is just to put a train of thought on the track—I'm more disgruntled than envious. In 1963 there was one FAA employee per 1.9 civil aircraft; the FCC has one employee for each 1,500 licensed stations. Of course I wouldn't suggest the FCC headquarters be weighted with retired military brass, paralleling what may have been only a happy accident and not an FAA stratagem. That would be as gauche as remarking that among Congressmen one finds more evidence of proprietary interest in broadcasting then airlines. For whatever reason, in contrast to more robust agencies, distinctive austerity seems to be the lot of the FCC when Congress weighs out the fiscal funds.

In spite of being short-handed and strapped for ready cash the FCC functions. Commission personnel are organized in four operating bureaus, and one of these is Field Engineering. In its Information Bulletin No. 3-G dated January, 1965, the Commission says that more than one fourth of its employees are in this bureau, so presumably four hundred would be a generous estimate. Defining its work assignments, the bulletin continues: "It is engaged largely in engineering work. This includes monitoring the radio spectrum to see that radio station operation meets technical requirements, inspecting radio stations of all types, conducting radio operator examinations and issuing permits to those found qualified, locating and closing unauthorized transmitters, furnishing radio bearings for aircraft or ships in distress, tracing and remedying causes of interference to radio communication, doing special engineering work for other Government agencies, and obtaining and analyzing techical data for Commission use." Quite a workload for four hundred men spread out over the United States, remembering that whole systems we accept as commonplace today were experimental or even unknown in 1940. The

microwave explosion, lofting of communication satellites, new transmission techniques and accelerating Defense Department demands on the spectrum are only a few of the most recent headaches for the Commission. The Field Engineering Bureau must remember 1940 as the last of the good old years, for in the next twelve months the first commercial FM station was licensed and the first commercial TV broadcast started us on the long trek to Newton Minow's Wasteland. Today there are nearly 1200 FM and 564 TV stations. Industrial and safety services have expanded tremendously; interference control work uses up valuable man-hours, and the Citizens Radio Service daily challenges the Commission's authority. Allocation, compatibility and monitoring problems will multiply as the state of the art advances.

Let's join hands and observe a minute of silence while we contemplate the chaos our panadaptors would display if Commission personnel weren't knocking their brains out housekeeping for us. Then let's tip our collective hat to the R.I.—if Congress continues to neglect the FCC we may have to pass it around to keep him in business.

. . . W7IDF

(W2NSD from page 4)

Modes All cards submitted for a certificate must specify the mode used in transmitting and all must indicate the same mode. Separate certificates will be available for CW, Phone and RTTY. There will be no differentiation between various phone emissions such as AM, SSB, NBFM, etc.

Time Limit All contacts must be after May 1, 1966 and contacts within any one calendar year will count for that particular year. Cards will not count for more than five years. This means that contacts made in 1966 will count towards the certificate only through 1970.

Bands All cards submitted for a certificate must indicate the band used for the contact and all must be for one single band. Different certificates will be available for each band.

We have no plans for issuing certificates for multi-band countries or for phone/CW countries. QST handles these hydrids reasonably well and we certainly don't want to duplicate their certificates.

We've done a lot of figuring to see how little we would have to charge for these certificates. It would be nice to send them out free, but the money for them has to come from somewhere and no angels have volunteered as yet to foot the costs. By the time you add up to the cost of buying the certificate blanks, setting the tvpe, making the photo negatives, stripping the negatives, making the printing plates, printing the certificates, filling them out, addressing them, mailing them, postage, mailing tube, hand lettering calls in on the certificates, keeping the many records, and a lot of miscellaneous items it comes out to about 90¢ plus per certificate. No doubt we will be accused of crass commercialism for not giving these away, but we'll have to live with the criticism and charge one dollar per certificate . . . or seven IRCs for DX ops.

We'll do our best not to make a CQ out of ourselves with the QSL cards. You'll get them back in short order if you include a SASE (self-addressed stamped envelope) and an original plus a duplicate of our certificate record form. We'll send you the record forms starting in June if you send SASEs for them.

No doubt we will have a lot of questions to answer about this and probably have to come up with more detailed rules as exceptions rear their ugly heads. The purpose of the certificates are to try to make your DXing more enjoyable.

We'll no doubt make quite a fuss over the first chap to submit 100 cards all dated after May 1st. In case of tie we will look for the postmark. Gus plans to list the top certificate holders for each band and mode in 73.

By using the country lists of national amateur groups we have no problem of getting on the hook enjoyed by Bob White at QST. We do reserve the right to be as dictatorial as Bob, but I doubt if we will exercise this right. There will be one major difference between DXCC rules and ours: stations aboard ship within the territorial limits of a country will count for that country. This is not so much of a change as it is a recognition of a fact of life. Up until now there have been several "countries" accepted for DXCC that actually were operated from aboard a ship at anchor. We feel that if the fellow is there it should count and no manure about it.

Somewhere else

In recent years we've had the interesting spectacle of DXpeditions that weren't exactly where they were supposed to be. The temptation is a strong one, of course. Just put yourself in the position of a DXpeditioner . . . you are sitting on some remote spot signing a fine exotic DX call and everyone is calling you like mad. Then after a few days you find that you've worked out the bigger pileups and are now down to the low powered non-DXers who like to pick up a country, but don't really care that much about it.

Well, you've got to pack up all that damned equipment, get it loaded onto a boat, sail for a few days and then unload it all again onto some deserted island or some place where the natives can hardly read or write and put up your antennas, etc. Wouldn't it be a lot easier to sit back with a book for a day or two and then fire up again with the new call? No one but you will ever know, so what's the difference if you are a hundred miles one way or the other?

My question is this: does it make any difference? Several thousand fellows have worked a "new country" and it has been accepted by the League . . . everyone is happy . . . right?

Of course this sort of thing can be run into the ground. With the QSL manager type of operations that we have today almost any bootlegger could, with the help of a friend . . . or even alone . . . give us quite a rash of new countries.

Bootlegging may turn out to be a way to beat the high cost of QSL's. Apparently the League is solidly behind the $25 per QSL concept, if we are to believe the interesting and illustrated talk given by one of the DXCC Committee at the Miami Hamboree. Or per-

(continued on page 118)

David Middelton W7ZC
Springdale, Utah

Those Good Old Ham Bands!

Have you taken a serious look across any ham band lately? Or are you one of those "restricted frequency" operators who listens and works only on a few kilocycles?

If you are concerned with the present state—and the future—of amateur radio, you'd better take some time off from those round tables, traffic relays or phone patches and see what is actually happening on your AMATEUR bands.

What you will hear will shock and rock you! It will make you wonder, (if you have been on the air more than a couple of years)—where *are* those good *old ham* bands?

A listen on 40 or 80 will open your ears and make you wish for the OLD Bands more than ever.

The shocking truth is that 40 and 80 are NOT *ham* bands any longer—at least not the type ham bands we had which made ham radio a lot of fun and use!

Long concerned with this problem, I recently was piqued by a note from W2NSD/1 —"Nov. 18—tonight I tuned from 3800 to 3900 kc and heard loud commercial RTTY or CW signals on fourteen spots. Each of those signals took up from 3 to 5 kc. Therefore—60 to 75 kc of these 100 kilocycles were unusable for amateur use!"

So, on the evening of Nov. 30, I tuned clear across the 40 meter band, from 7.0 to 7.3 mc and I counted FIFTY ONE non-amateur signals, on ONE trip (15 minutes) across the band. These included propaganda stations, jammers, RTTY and CW (commercial type) plus a lot of unidentifiable crud. These signals occupied from one to 10 kc, so there was not much room for amateur operation.

Or was there? This one trip across 40 meters (as mentioned above) revealed a terrific lot of amateur QRM with stations piled up in heaps, both on CW and 'phone, and with empty space where one could drive a Mack truck through—except for the non-amateur stations lying therein. Many of those non-amateur signals could have easily been overridden by even a moderately strong ham signal, but no Amateur was using these frequencies!

Why?

It has been noted by those concerned with such goings-on, that ANY band tends to become cluttered and QRM'ed with roundtables, traffic and RCC nets, or DX pile ups—in discrete spots on the band, and with most of the band wide open, except for non-amateur use or at times with NO one using these frequencies.

Calls in those "holes" are usually rather non-productive to a CQ. This is a complete mystery to many experienced operators. Having grown up on the bands when EVERYONE tuned all over the band—(or else he didn't work anyone) I am amazed to find this crowding technique operating to severe detriment of amateur radio.

True, some of the non-amateur signals, (and most notable our very own VOICE OF AMERICA stations) are impossible to work through. Surely there are other frequencies being used for non-amateur operation that could and should and MUST be occupied by US—the amateurs. It is our band, too!

Is it *timidity* that keeps amateurs off these frequencies. Perhaps it is, in part. This constantly growing tendency of Americans to be non-controversial about *anything* has innoculated some of them even to refraining from fully using their own bands.

Is it *ignorance*? Ignorance of why this non-amateur is there, on our ham band? Perhaps so, however anyone worthy of holding a license can easily determine in a few short seconds if the signals are legitimate amateur operation or not.

Is it the present and increasing trend of an *inability* to copy through QRM? If this applies to you—then you better turn in your ticket! You do not deserve or are you entitled to a "clear frequency" in spite of the shouts of those ubiquitous phone-patchers.

Copying through normal QRM (NOT the *deliberate* QRM generated by some so-called amateurs today) has always been an operator's greatest asset and achievement. It was not until after WW2 when the GI-trained hams hit the air, that we ever heard anyone demand

"a clear frequency". If you could hear them, you read them—it was as simple as that. The best filter in the world is between your ears. Couple that with mechanical or crystal filters —and any *good* operator can take a lot of copy before he yells uncle!

So—you listen for these holes, determine that the incoming signals are non-amateur in origin from some guy who is too timid to call CQ, —and pour on the coal! You might get a reply but who chanced to forget that he is Casper Milquetoast long enough to give you, O Brave One, a call—and a good QSO result! Try it and see!

We Amateurs had better OCCUPY all the space on the bands we have now—or we may not have *any* space, tomorrow!

The intruders and the Institute

If you want to help—take a trip across any of the bands with which you are familiar. Note the time, frequencies and type of non-amateur signals you hear. List this information in a legible manner and send it to IoAR HQ. When we receive enough such data, it will be gathered together and sent to Washington, D.C.

The IoAR IS concerned and would appreciate YOUR cooperation in this program, whether member of IoAR or not.

. . . W7ZC

Jim Kyle K5JKX
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Low Pass Audio Filters

The FULL Story

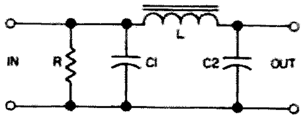
A low-pass filter (the audio variety, rather than the rf version) is an integral component of every amateur station, yet almost none of us have any real understanding of how they work.

While the filter mentioned a second ago is the one which takes the ripple out of the power supply, low-pass filters for use in the audio chain of both the transmitter and the receiver are also in wide use. If we understood them a bit better, their use might be virtually universal.

One of the things that confuses the filter issue so much is its apparent simplicity. Especially at low power levels, the power-supply filter is usually "designed" by simply picking out a choke that will carry the load current, putting as big a capacitor as we can afford on either side of it, and soldering the connections. What's more, this approach usually works.

Unfortunately, a similarly free-wheeling approach doesn't work so well when we get up into the voice-frequency range. And since at least two major design techniques are employed, with each of them subdivided into several smaller types of filter, most of us just tend to ignore the subject altogether.

This is usually a mistake. A low-pass filter designed to "cut off" at 3 kc will, in itself, make a significant improvement in signal-to-noise ratio if added to your receiver. It does this by passing all essential voice frequencies unaltered, yet knocking down the level of random-noise components above the cutoff frequency. Since our ears are most sensitive in the 3-to-6 kc region, the 6-to-15 db reduction in noise energy between 3 and 6 kc shows up as *more* than that amount of improvement in signal-to-noise.



$$L = \frac{2R}{6.28f}$$

$$C_1 = C_2 = \frac{1{,}000{,}000}{6.28f \times R}$$

Fig. 1. Basic three element low pass filter.

In the SSB transmitter, the low-pass filter helps assure that the signal takes up no more spectrum space than necessary. While most of us assume a SSB rig has a 3-kc-wide signal, if it's modulated with input up to 10 kc and the exciter bandwidth is broad enough, the signal will be that same 10 kc wide.

In other types of phone transmitters, the low-pass filter keeps bandwidth at the minimum possible. With AM or DSB, it will hold it to 6 kc. With FM, bandwidth doesn't depend entirely on signal frequency but rather on amplitude, but the filter is a definite asset even here.

Back to the receiver, even if the *if* bandwidth is only 3 kc noise can still appear in the audio chain outside the 0-to-3 kc region; if the low-pass filter is near enough to the output stage, this noise will be eliminated and the S/N improvement will still be noticeable.

So you *should* have a 3 kc low-pass filter. You can buy them but they're expensive. So let's look at the ways and means of making them for ourselves.

As a starting point for this, let's look at the various design techniques. We may not end up actually using any of the things we find out along the way, but we will at least know what we're doing when we get to the soldering iron stage!

The two major design approaches (which apply to all filters, rather than just to low-pass af units) are known as the "image parameter method" and the "modern network theory" approach. Let's examine them both.

The "image parameter method" is the older of the two, and has been the standard filter design technique for more than 30 years. This approach starts out with the assumption that the filter is terminated at each end in an impedance which looks to the filter like another filter section. The closest analogy in most ham experience is the "flat" antenna feedline, which when terminated in the proper impedance looks from the other end as if it were infinitely long. Similarly, a properly-terminated image-parameter filter looks as if it contains an in-

finite number of sections.

To put it another way, the properly terminated antenna feedline also looks as if it's not there at all, since no matter how long or how short it is, the impedance looking into it remains the same as that of the antenna. And a properly terminated image-parameter filter will also appear not to be there, since its input impedance is the same as that terminating it.

In practice, the match can't be made exactly perfect. Over a reasonably narrow bandwidth, a purely resistive termination (such as a 500 ohm or a 1 megohm resistor) is a useful approximation to the proper terminating impedance, and tris is the way the filter is actually used.

While the mathematical derivations of all the design equations are exceptionally highbrow, the design equation itself for a low-pass filter such as that shown in **Fig. 1** is simple enough. The value of L (in henries) will be equal to twice R, divided by 6.28 times cutoff frequency in cycles per second. R is the impedance; if both ends of the filter are to see the same resistance value, R will be equal to this resistance value in ohms. If input and output terminations are to be different, R equals the square root of the *product* of these values (each expressed in ohms).

If both terminations are equal, C1 and C2 will both be equal and their value will be 1,000,000 divided by 6.28 times cutoff frequency in cps times R; the result is in microfarads.

If terminations are unequal, and C1 is to be on the low-resistance end of the filter, C1 will equal 1,000,000 over 6.28 x freq x R_{low}, while C2 will be similar except that R_{high} is used in the equation.

These are the standard "handbook" equations for low-pass filter design, and as mentioned previously have been in use for more than 30 years. A filter designed in this manner and terminated in its design impedances has a *theoretical* cutoff curve which is 3 db down at cutoff frequency, 6 db down at 1.15 times cutoff frequency, 10 db down at 1.4 times cutoff, and 20 db down at 2.14 times cutoff. From there, attenuation increases by 18 db every time the frequency is doubled.

With a 3 kc cutoff, such a filter would theoretically be 18 db down at 6 kc, and 36 db down at 12 kc. The −60 db point isn't reached, even theoretically, until the frequency reaches 30 kc.

But note that these figures are all theoretical. The theory demands, however, that the filter be properly terminated—and we don't

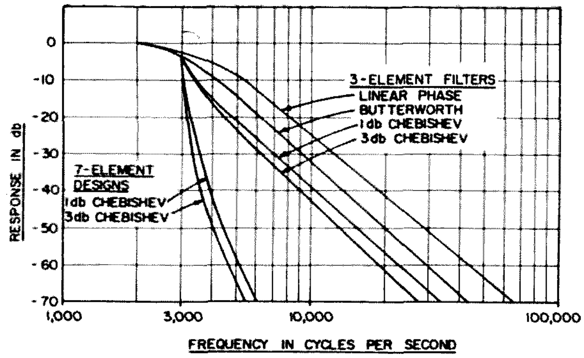


Fig. 2. Filter cutoff curves.

have a perfect termination. In fact, the image-parameter method of filter design demands terminating impedances for the resulting filters which are *physically impossible* to achieve. These terminations must be pure resistance at dc, yet with increasing frequency must reduce resistance (like a capacitor) to a complete short-circuit at the cutoff frequency, then increase resistance (like an inductor) as frequency continues to rise. They must still look like inductors at "infinite frequency" which is somewhere way above the laser in the spectrum!

Using pure resistances instead of these impossible impedances as terminations automatically makes our design incorrect, and as a result the theoretical cutoff curve is seldom approached in practice. The commercial acceptance of image-impedance designs over the years has been due in no small part to the extremely approximate requirements in most filtering applications. There's another reason, too, which we'll get back to much much later.

The other approach to filter design, the "modern network theory" design technique, came into being as engineers tried to overcome the basic limitation of the image-impedance approach. They set up "circuit equations" describing the performance they wanted, then applied network theory to solve these equations.

And when they did, they found that they had a few bonuses. The modern network theory technique let them specify not only the cutoff curve, but freed them from the requirement of specific terminating values as well. Either the input or output termination can be either a short circuit or an open, something not possible with image-parameter design, and the designer can specify at least one other filter characteristic in addition to the cutoff curve shape.

They had to pay a price for all this, though, and the price was an extremely complex de-

sign procedure. We don't pretend to comprehend all the mathematics involved in it. If you want to try, you can start with the *Journal of Mathematics and Physics,* volume 18, pages 257 to 353, where an article by S. Darlington titled "Synthesis of Reactance 4-Poles" appears. We haven't seen it and aren't eager to; the reference is taken from a footnote in another book.

In fact, this design technique barely got off the ground back in the old days before computers. But the high-speed calculating gadgets took the drudgery out of the mathematics, and let the theoreticians work out some charts. These charts, in turn, made it possible for a run-of-the-mill engineer with an M.S.E.E. to design a working filter using modern network theory.

That's still quite a ways from the Joe Ham level, but if you want to see the charts you can find *them in Reference Data for Radio Engineers, Fourth Edition,* pages 187 to 235. Earlier editions of this book don't have them.

After the design charts were published, a number of people became enthusiastic about the performance of these new filters, and the word began to get around. For the most part, the users didn't call them "modern network theory" filters. As we said before, the designer has the freedom to specify at least one other characteristic of the filter in addition to its cutoff curve, and the design equations for the filter depend somewhat on just what characteristic the designer decides he wants. The equations fall into general classes known to mathematicians by the names of scholars who first worked with the particular class of equations, and the filters became known by the name of the class into which their design equations fell.

So we started having Tchebychev filters (sometimes spelled Chebishev, Chebisheff, Tchebichef, or any other similar combination depending on how you prefer to transliterate Russian into English pronounciation!) and Butterworth filters showing up here and there.

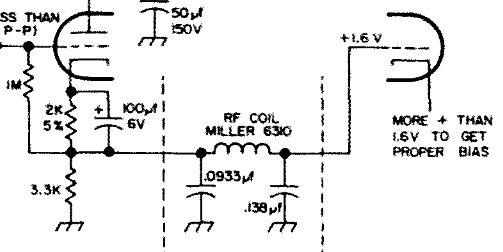


Fig. 3. Three element Chebishev filter for 3 kc with matching stage as designed in text.

In radar and certain kinds of computer work, there was a need for a filter which would transmit a *pulse* smoothly, and this called for a special phase characteristic. The resulting filter was known as a "maximally linear phase" design. But *all* of these are modern network theory filters.

What do they do? Let's start by seeing what they all have in common. They can be designed for any desired value of terminating impedance, and one of the two terminations can be either an open or a short circuit. This means that we can design a filter to feed a vacuum tube grid circuit without having to waste any power in a terminating resistor (provided a dc grid return exists through the filter itself). They can be designed for almost any cutoff curve shape.

The Chebishev (that's the simplest spelling) filter provides the sharpest possible cutoff rate, at a small price. The price is "ripple" in the passband, which means that instead of having an absolutely flat response below the cutoff frequency, some frequencies below cutoff will be attenuated slightly as compared to others. However, this ripple can be reduced to a value as low as desired, by trading sharp cutoff for low ripple.

A Chebishev design using the same *electrical* circuit as that of **Fig. 1,** but having 3 db variation of response within the passband, will be 29 db down an octave above cutoff frequency. This is 11 db more attenuation than the theoretical curve of the image-parameter design, and what's more, this is the *practical* value as well as the theoretical one. With the image-parameter design, the theoretical value could never be reached.

If we reduce the passband ripple of this filter to 1 db, which for ham use would be flat so far as we could ever tell, it's still 27 db down an octave above cutoff, 9 db better than the older approach.

When the passband ripple of the Chebishev design is reduced to nothing at all, we find that we have (instead of a Chebishev equation) a "Butterworth response". As we would expect when trading cutoff slope for passband flatness, the cutoff isn't so sharp as that of the Chebishev. In fact, it's identical with the theoretical cutoff curve of the image-parameter design. This slope, however, is achievable whereas the theoretical design of the image-parameter filter isn't possible. We'll come back to this point later.

Slowest of all the modern-network-theory filters in cutoff rate is the maximally-linear-phase design. It is only 12 db down at twice the cutoff frequency, and doesn't reach its

full cutoff rate until almost three times cutoff frequency is fed through it. At that point, it's 21½ db down, and attenuation increases from there at a rate of 18 db per octave.

Keep in mind that all the way through this we have been talking about the simple two-capacitor-one-inductor filter configuration of **Fig. 1.** Much sharper cutoff is obtainable by using additional reactive elements in the filter. A 7-pole Chebishev design, with four capacitors and three inductors, can be made to be 70 db down at just twice cutoff frequency, and this with only 1 db of ripple in the passband. Allowing 3 db of passband ripple would get us another 5 db of rejection at twice cutoff frequency, or a total of 75 db down. This is truly signal-slicing performance.

But as pointed out earlier the use of modern network theory filter design techniques allows us to improve our cutoff rate by some 10 db (approximately) in the important region just above the cutoff frequency with even the simple 3-element filter of **Fig. 1,** so let's go into the simple filter a bit more thoroughly.

Along about here, you're probably thinking "This is all very well, but if a graduate engineer has difficulty designing a filter by these methods then what are they wasting all that space for!" There's a reason, and we're about to unveil it. Before we do, take a look at **Fig. 2** which is a response curve showing the performance of various filter designs. This shows more clearly than words the differences between the tvpes we've been talking about.

Fig. 2 should complete the job of selling you on modern network theory designed filters, and prepare you for the idea of building one for yourself. Don't worry about the complexity of the design technique.

Here's why you don't need to worry: While the charts and equations are indeed formidable, the actual filter itself looks just like the ones in your receiver power supply, that shown in **Fig. 1.** So far as construction of the filter is concerned, the only difference between a 3 db ripple Chebishev and an old image-parameter design is in the parts values employed.

And in digging through all the design data, we stumbled across a technique which bypasses all the complexity and gives you the proper parts values almost instantly.

Interested? We'll warn you right here that there's a little arithmetic involved, but it's no more complicated than that you must use to determine row big a resistor must be to drop the voltage for your screen grids.

The starting point for our new design technique is a "table of coefficients" which appears as Table 1. As you can see, the fancy name refers only to a list of numbers. For any one type of filter design, there's one number which applies to C1, another to C2, and the third to L. The different values which these numbers have from filter type to filter type makes the difference in the design.

Or in other words, this table of coefficients includes everything that differs from filter to filter, for all the filter types listed.

Along with this, you'll need a reactance chart unless you want to calculate reactance values according to the classic formulas. Inductive reactance equals 6.28 times frequency in cps times inductance in henries, while capacitive reactance equals 1 over 6.28 times frequency in cps times capacitance in *farads* (to use mf. instead, put 1,000,000 above the line instead of 1).

Decide what impedance values you want for terminating the filter, and what you cutoff frequency is going to be (in case you haven't gathered, "cutoff frequency" is that frequency at which response drops 3 db). Use the reactance chart or the formulas to determine how many henries of inductance provide reactance equal to the terminating impedance, at cutoff frequency. For instance, if terminating impedance is to be 470 ohms and cutoff frequency is to be 3 kc, the inductance value corresponding to these values will be 25/1000 henry or 25 millihenries.

Similarly, determine the amount of capacitance required to provide reactance equal to the termination at cutoff frequency. For 470 ohms and 3 kc, the value is 0.113 μf.

Now go to the table of coefficients and pick out the type of filter you want. Multiply the inductance value you just determined by the "L" coefficient for your desired filter, and multiply the capacitance value by the "C1" coefficient to get the value of C1, and by the "C2" coefficient for the value of C2.

For example, to continue with our 470 ohm 3 kc design, let's see what values give us a 1-db Chebishev filter, if the output of the filter sees an open circuit (such as the grid of an amplifier tube with no shunt resistor). The "L" coefficient is 1.465, so we multiply our 25 millihenries by this value and find that we need a 36.7 mh inductor. Similarly, C1 must be 1.11 times 0.113 μf, or 0.1255 μf, and C2 is 1.64 times 0.113, or 0.1855 μf. The 470 ohm side of the filter is that on which C1 appears.

Now that we have our values, what can we do with them? None of them are over-the-counter items at our friendly radio store. We could go out and get an expensive variable in-

FILTER TYPE	Image Parameter	Linear Phase	Loaded Butterworth	Unloaded Butterworth	Loaded 1-dh Chebishev	Unloaded 1-db Chebishev	Loaded 3-db Chebishev	Unloaded 3-db Chebishev
C1	1	0.338	1	0.50	2.21	1.11	3.36	1.68
C2	1	0.455	1	0.67	2.21	1.64	3.36	2.03
L	2	1.023	2	0.75	1.09	1.465	0.71	1.17

Table I—Coefficients for 3 element filters

ductor for L, then try to set it to the precise value. But we have a few other choices too.

For instance, good quality inductors are available in certain fixed values. The RTTY gang has been using 88 mh toroids for years; 44 mh toroids are available just as easily (the 88's actually have two 22 mh windings, in most cases).

High-inductance rf coils are also easily available. For example, J. W. Miller Co. lists a type 6308 25 mh coil, ±5%, for less than $1.50. They also have a 6310 50 mh unit for about the same price. Adjustable rf coils can also be purchased, if you have any means for setting the value to precisely what you want and knowing when you get there. Miller has a line in their 22A series (22A102RBI through 22A101RBI) which offers complete coverage from 5.3 mh to 125 mh., and the most expensive is priced just under $2. All of these coils have fairly good Q, which is an important point in modern-network-theory design.

When you need more inductance than these values, as you will if you design filters with impedances up in the 100K to 1 megohm region, then the simplest way to do it is to work backwards. Do a preliminary calculation as just described to find out the inductor value needed for your original set of specifications. Pick the closest value to this you can get, and reverse the entire procedure.

Going back to our example, let's re-work it to use that Miller 6310 50 mh coil just to show how this backward approach works. We know that the actual coil value is 1.465 times the reactance value, so for the actual coil to be 50 mh the intermediate reactance value for the coil must be 50/1.465 or 34.1 mh. This is the value with which we enter the reactance chart. The chart tells us that 34.1 mh will have 470 ohms of reactance at 2.2 kc, and that at 3 kc the reactance will be 641 ohms.

To use the 50 mh coil, we have a choice. We can move our cutoff frequency down to 2.2 kc, or we can increase our terminating impedance to 641 ohms. The preferred procedure usually is to increase the terminating impedance, because the cutoff frequency is one of the more important design characteristics. The terminating impedance usually is more a matter of choice and convenience.

With the impedance changed to 641 ohms, we recalculate the values for C1 and C2. They come out to be 0.0933 µf at C1 and 0.138 at C2; a 0.0091 µf 5% tolerance unit for C1 and a 0.14 uf 2% tolerance unit at C2 would probably be plenty close enough, but if you prefer to be a bit more precise you can build up the values by parallelling capacitors until you reach the exact figures.

To get the filter terminated properly in 641 ohms, now, may take a bit of doing. The starting point would be a 680 ohm 5% composition (not wirewound) resistor across the input. If the filter is to be fed from a 500 ohm source (transformer or line) an 11K ohm resistor in series between the source and the filter will both isolate the low source impedance from the filter, and transform the total terminating impedance to 643 ohms which is plenty close enough. However, the voltage-divider action of the 680 ohms and 11K in series will result in some 44 db of loss, so the idea doesn't work out too well. Note that this loss is in the terminating network *ahead* of the filter, not in the filter itself.

A cathode follower stage may be designed to have almost any desired output impedance, and this is probably the best way to match that 641 ohms. Output impedance at the cathode itself, in the cathode follower, is approximately equal to 1/gm where gm is the tube's transconductance. A 12AX7 operating at 100 volts from plate to cathode and −1 volt grid bias has a gm of 0.00125 mho, so output impedance would be 800 ohms. The cathode resistor (load resistor) is effectively in parallel with this, so by using a 3230 ohm cathode resistor we could get our 641 ohm impedance (800 ohms and 3230 ohms in parallel equal 641 ohms). Using a standard value 3300 ohm resistor would raise output impedance only 2 ohms and would be the way to do it.

Under these operating conditions, the plate current of the tube is ½ ma, which would give 1.65 volts across the resistor. Since we want only 1 volt bias, the load resistor and the bias resistor must be made separate. The 3300-ohm load resistor and a 2K, 5% bias

resistor would be placed in series, with the 2K connected to the cathode and the 3300 to ground. The 2K would be bypassed with a high-value low-voltage capacitor (say 100 μf at 6 volts) and the grid resistor would be returned to the junction of the two resistors. Output would be taken from this same junction.

With such a hookup, the "gain" of the cathode follower would be approximately 0.8, which is less than 2 db loss in the matching. Although a few more parts and another tube are required to do it, the result is 42 db less matching loss.

The circuit for this particular matching arrangement is shown in **Fig. 3**, which also includes the filter (separated by a dashed line). Input impedance at the 12AX7 grid is about 10 megohms; it can be connected to almost any point without loading the source.

While we've gone into considerable detail for our sample 1 db Chebishev filter design, the same approach is true for any filter type listed in **Table I.** Simply pick your filter, using the curves in **Fig. 2** as a guide, and follow the procedure through, working backwards if necessary to use the parts you have available.

Quite a ways back there we mentioned that there was an additional reason why the image-parameter filter, though theoretically impossible, had been such a success through the years.

The sharp-eyed among you may have already noticed that the coefficients listed in **Table I** for the image-parameter filter values and for the *loaded* Butterworth-response filter are identical. This is no error. The two designs come up with identical parts values, though the approach by which they are achieved varies radically.

And the Butterworth is a modern-network-theory design, which does allow the theoretical performance to be achieved, while the image-parameter approach doesn't.

If all this seems to be somewhat confusing, don't be larmed. It's confusing to the engineers, too. The real difference is in the mathematical excursions underlying the design.

Perhaps this will be made a bit more clear by taking a couple of examples. An image-parameter filter can be designed (by its theory) to be placed between two unequal impedances, something like a quarter-wave antenna feedline is used to match the different impedances of line and load. For instance, a 500-ohm image-impedance filter could be terminated in 500 ohms at each end, or it could be placed between a 250 ohm source and a 10,000 ohm load. It would make no difference in the design of the filter; parts values would remain the same. But the loaded-Butterworth design which uses the identical parts values could be used *only* with 500 ohms in, and 500 ohms out. The values would be wrong, with any other set of terminations.

Since many image-parameter filters *are* used between equal impedances, where they are identical in performance to the Butterworth (or for that matter, *are* Butterworth filters), the results have naturally been good. But the theory on which they are based cannot explain the performance, as can the modern-network-theory approach.

This is why you don't find the image-parameter filter curve shown in **Fig. 2**; it's the same as the Butterworth, if the filter terminates in equal resistances. If not, the curve can't be drawn.

A bit should be said about some of the terms we've been tossing around. As we use it, a "loaded" filter is terminated in equal impedances at each end. An "unloaded" filter is terminated in its design impedance at the input, but output sees an open circuit such as a tube grid without shunt resistance. If some dc return is needed on the output, shunt resistors can be used provided that their value is at least 10 times (and preferably more) that of the filter's design impedance.

Notice that we haven't mentioned the M-derived filter; this is deliberate. Design and construction of a good M-derived filter is much more difficult than that of a sharp-cutoff modern-network-theory design, and the MNT design can give just as much attenuation without any of the accompanying problems.

Should you want or need these sharp-cutoff characteristics, you can use the data in **Table I** with the design technique already described to obtain values for 5, and 7 element MNT filters. Here's how: you design a 1 db ripple 3 element Chebishev, loaded, and then build *two* of them. The two are then stacked end-to-end (combining C1 of the second with C2 of the first) to form a 5 element filter. Similarly, three of them form a 7 element. With this approach, 7 element performance is achieved while retaining 3 element design simplicity. Keep in mind that the ripple, like the rejection, adds together, so that three 1 db ripple designs stacked up on end would have a total of 3 db passband ripple.

Which brings us to the end of the story about af low-pass filters. The rest is up to you; dig out those old filter chokes and the soldering iron, and give your rig another 10 to 20 db of effective gain!

. . . K5JKX

NEWS FROM THE INSTITUTE OF AMATEUR RADIO

Compiled by A. David Middelton W7ZC, Secretary

Challenging contest for young members

In keeping with the Institute's program for advancement in amateur radio through individual effort and achievement, IoAR announces its first Building-Writing Contest—open *only* to IoAR Members whose birthdate falls after July 15, 1946.

First Prize—a $25 Savings Bond, and publication at space rates in 73, for the best construction article for an original piece of AR equipment having at least *five* tubes or transistors.

Second Prize—a $15 Gift certificate, (good toward the purchase of any 73-advertised merchandise) and publication at space rates in 73 for the best construction article on an original piece of AR equipment having at least *three* tubes or transistors.

Third Prize—a $10 Gift certificate (good toward the purchase of any 73-advertised merchandise) and publication at space rates in 73, for the best construction article on an original piece of AR equipment having less than three tubes or transistors.

All design, construction, photographs and text material must describe only original equipment. Entries must not be copied from articles or equipment in any magazine or handbook. Kit construction or modifications, in any form, are not eligible.

All material submitted will be considered by competent IoAR-selected judges. Their decision will be final. Certification of contestant's birthdate may be required by the judges. IoAR membership will be checked by the IoAR Membership Dept. No correspondence will be conducted by IoAR HQ regarding this contest.

Non-winning entries will be returned only if accompanied by adequate first class postage.

To be eligible for this contest, entries must be receieved not later than July 15, 1966, at IoAR HQ, Springdale, Utah, 84767.

IoAR acclaims VHF-UHF performance

The Institute announces its new VHF-UHF certificate—"For Outstanding Performance on the VHF-UHF bands" based on certified two-way QSOs above 144 mc. This Certificate will be presented to any amateur for the first *ten* states worked on VHF-UHF, and certified. Later endorsements will be given for each additional *ten* states, worked and certified, in writing.

The Institute will present its "IoAR 50" trophy to the *first* amateur who makes two-way VHF-UHF contact with *all* fifty states, on frequencies above 144 mc. The recipient will also receive wide and appropriate recognition for this outstanding demonstration of VHF-UHF technical and operational skills.

IoAR, quick to recognize the importance of the new techniques and skills required in making DX contacts thru repeaters and satellites, *welcomes* inclusion of valid conformation of such contacts in all applications for both the IoAR 50 Award and the VHF-UHF certificates.

The IoAR certificate of merit

The Institute offers Certificates of Merit to any amateur meeting certain technical requirements, as follows:

"For Individual Technical Achievement" to those who hold a valid Extra Class license issued by FCC, or its foreign equivalent—or those who pass a comprehensive written technical examination prepared by IoAR and given under the direct supervision of IoAR Members at club, IoAR chapter, hamfest or convention sessions.

Arrangements must be made, by an IoAR Member, through HQ, for at least two persons (at one time) to take the examination at a specified club or chapter meeting.

Examinations will be conducted at conventions and hamfests when suitable arrangements are made, well in advance, between the sponsoring committee and the IoAR.

This IoAR examination consists of a number of multiple-choice questions covering the entire technical field of AR, including theory and practice. Completed test papers will be returned to IoAR HQ for grading. A passing grade of 75 will be required.

If this grade is not achieved, the applicant may again take the test after 12 months. No code test is included.

IoAR—Totally Dedicated to the Betterment and Preservation of Amateur Radio.

IoAR attends SAROC

The first Sahara Amateur Radio Operator's Convention, January 7-9th, sponsored solely by Hotel Sahara, Las Vegas, was a huge success.

IoAR's booth was staffed by W7ZC and his wife Charlet, ably assisted by IoAR members, WA6VTL, W7BIF and others. We met many friends of IoAR and made a lot of new ones (and members) through the medium of IoAR literature and plain talk about IoAR aims and accomplishments.

IoAR was the only amateur organization officially represented at SAROC. 73 was the only ham magazine having a display or representation. We were one of the twelve exhibitors.

SAROC was and will be an open convention. It was not "controlled" so everyone had a ball because there were no boring speeches.

There were excellent prizes, a registration of 339, plenty of ham spirit, exciting technical talks including one on space communication, plus fun and extra treats provided by the Fabulous Sahara! This was a convention to remember. Hotel Sahara has announced January 5-8, 1967 for their Second Annual SAROC.

Las Vegas coordinates AR and CB

Radio amateurs and CB'ers in Las Vegas, Nevada, are organizing a joint AR-CB emergency facility. WA7EMP, the prime-mover of this worthwhile effort, asked IoAR to seek information from groups in other localities who are working on similar projects. News on either positive or negative results would be welcomed by WA7EMP.

Note to new readers

If you are reading your first "News of the IoAR column, plase be advised that information of vital significance was contained in the January and February '66 issues of 73. If you are unable to obtain a copy, write IoAR HQ for a reprint, available until limited supply is exhausted.

Membership in IoAR

If you approve of this IoAR approach and are not a member we extend a hearty welcome for you to join us.

The IoAR story on tape

IoAR is preparing tapes (3¾ ips, monaural) to be made available to clubs.

The narrated stody of IoAR will be 15 to 20 minutes in length and will include details on the purpose and goals of the Institute, its membership and organizational structure, its awards and other informative IoAR data.

These tapes will be loaned to clubs, without charge. IoAR HQ will appreciate their prompt return after they have served their purpose in your group so that we may send them out to another club.

Important IoAR Addresses

For all correspondence except that regarding membership and supplies:
Institute of Amateur Radio
Springdale, Utah 84767

For membership correspondence and IoAR supplies:
Institute of Amateur Radio
Peterborough, N.H. 03458

The IoAR Story——on tape——will add a unique touch to your club meeting(

IoAR invites an officer of your club to make a written request to IoAR HQ for a tape;

Collector's item—The Oscar Story!

Last Spring, OSCAR 3 made radio history. The full story of the fabulous Oscar project is now told on a 1200 ft. 7.5 ips monaural tape thru the courtesy of K6LFH.

This historical narration and the "sounds of Oscar" is now available through Mrs. Marie Welsh, WA6VTM, for the incredibely low price of $1.25 postpaid; Get one of these tapes and learn about OSCAR, its problems, thrills and outstanding successes;

(WA6VTM is an active member of the Lockheed Amateur Radio Club and a Founding Member of IoAR.

INSTITUTE OF AMATEUR RADIO MEMBERSHIP APPLICATION

(Use separate sheet if desired)

Name . . . . Call . . . .

Address . . . .

City . . . . State . . . . Zip . . . .

. . . .$5 enclosed for one year membership in IoAR.

. . . .$7 enclosed for IoAR membership and one year of 73.

. . . .I am a new member of IoAR.

. . . .I am a Charter IoAR member and desire to have my membership continuous.

. . . .This is a renewal of 73 but a New IoAR membership.

Please send check or money order (cash sent at sender's risk) to:

Institute of Amateur Radio, Inc.
Membership Department
Peterborough, N.H. 03458

Gus Browning W4BPD

Gus: Part 10

I am writing this chapter while I am in Iceland. Just how I ended up in Iceland, in a few words is this: I departed from Glascow, Scotland for the Faroes Islands, and, as usual for this part of the world, the weather was foggy, rainy and cold. We left about 10:30 AM and at 1:30 PM we were over the Faroes. The weather had gotten worse and we were informed that the DC-3 could not land at the Faroes and we were going to go on to Iceland and probably would come back to the Faroes the next day. This was 3 days ago!

Yesterday I went on a tour to see some of the sights around Reykjavik. It was a very short tour but I did see some of the hot springs around here. I saw many places where steam was coming up out of the ground. One of these geysers could be made to flare up by putting soap down into it. This one squirted up about 150 feet, steam and hot water mixed together—boy, what a smell; just like rotten eggs! I saw one place where they had taken one of these geysers and were piping the steam to Reykjavik, 15 miles away, where it is used to heat the houses. I suppose this is the world's cheapest city heat. Up in this area also were many hothouses where they grow tropical vegetables and fruits. I actually saw bananas and oranges being raised here in Iceland! There were such items as tomatoes, melons, cucumbers, lettuce, etc., growing in profusion.

Last week I was down at 4U1ITU in Geneva during their annual get-together. Stu-W2GHK met me there and plans for the future were discussed at length. We have some good plans—sure hope they work out. K2HLB put on a good cocktail party for the gang there. Many good speakers were on hand and some very interesting things were discussed. Bill Orr W6SAI held the attention of everyone with his talk on satellite communications. (A hint: you fellows had better start learning more about this business of communicating by satellites—it's the coming thing, and I think maybe one of these days there will be a DXCC by satellite QSO's.) I even gave my little speech on DXpeditioning. Sure did meet some FB people there and hope next year Peggy and I will be able to attend together.

Looking out my hotel room here in Reykjavik I notice that every building here seems to be almost brand new. Things are really booming here. Just a few minutes ago I asked for a cup of coffee here at the Saga Hotel where I am staying and found that it was about 52 cents. Coffee in the Waldorf-Astoria in NYC is not that much. Bring plenty of money if you ever come to this place, because if this is a sample of how things are in Iceland, it will cost you plenty! Now it's time to get back to my story.

I was telling you that I made the trip from Nairobi to Dar-es-Salaam by African bus. I was the only pale face on the entire trip, which, incidentally, was very cheap, costing only about $6.00. The trip takes two days and one night. Three drivers were "used up," and I mean used up. I have never been able to decide who it was worse on—the bus, the drivers, or the passengers. The drivers were kikues and the passengers were Masais. Now these Masais usually had very long, very wicked-looking spears along with them. The driver of the bus made the men put these spears in the front on the bus, beside the driver, while the Masai warriors sat in the back—separated from their weapons. I asked one of the drivers why he made them put their spears up front and he just said, "Well, you can never tell what these fellows might do!"

When I went up to the office that was selling the bus tickets I was asked if I wanted first or second class tickets. After thinking it over a few seconds I said first class (100% higher cost. I was then told by the fellow selling the tickets that I should buy second class and to hand the bus driver a few shillings when the bus got outside the city and he would let me come up in the first-class part of the bus. When it came time for the bus to depart I went along with the natives to the

back section of the bus. The smells were a little on the strong side, I will have to admit. The bus driver saw me and told me to come up to the first-class section. I showed him my second class ticket. He said it was all right, that we could settle it later. So up to the front I went and I had the whole two front rows of seats all the way to Dar-es-Salaam.

This was a very informal type of bus ride. The driver would stop the bus for me any time I wanted him to, so that I could take pictures. When someone "had to go" they just yelled out and the bus driver stopped the bus and they just stepped outside the bus door. They are not bashful in the least. After leaving Nairobi in the distance, the bus started stopping to pick up and discharge passengers along the way. Many of the native women that got on the bus did not have on anything above their waists. When this first happened you of course observed their appearance—you just naturally observe things that are showing and flopping around. But after the first few hours you get accustomed to these sights and then you don't pay any attention to them any longer. Some W6 station told me that some of the bathing suits around San Francisco were being worn like this last summer. When I signaled the driver to stop, I headed for the bush and the bus driver said, "No, no, Bwana, lion in bush." Well from then on I "went native" like everyone else.

Along the way many wild animals were seen. Once three mean-looking elephants were in the road. The bus stopped and we waited until they got good and ready to QSY from the road. Another time a great big baboon jumped on the hood of the bus. The driver made everyone roll up their windows and he started blowing his horn, ring a loud bell, and slamming on his brakes, reversing the bus; but this baboon would hold on and would not be shaken off the bus. The driver said, "OK, you go to Dar-es-Salaam with us!" Away we went with the baboon on the hood of the bus. He stayed on for about 2 hours, and when we were meeting another bus he just jumped from our bus to the hood of the other, and I guess when he got back to his starting point, hopped off. A real professional hitch-hiker!

Monkeys? You talk about monkeys! One morning a little after sunrise we were going thru the jungle where the trees and bushes were very thick, when I heard the most ungodly amount of squealing and grunting. Here came the monkeys by the thousands. They were crossing the road, some hopping and jumping from limb to limb, small ones on their mothers' backs; big monkeys, small monkeys, monkeys of all colors, every one of them screaming and tearing across the road. The bus stopped and for well over five minutes the monkey parade streamed across the road. We saw many lions, mostly at night, a few leopard, and many hyenas, droves of zebras and many different kinds of antelope and deer. This was a fine trip and some day I would like to make it again if things cool off down here.

I was treated with respect and had no difficulty except once. The bus had stopped at a tea house for refreshments, and after I had my spot of tea (a Coke would have been much better) I went back to the bus and began watching all the Masai tribesmen. One of the old women of the tribe came up under my window and held out her hand for a "donation." The only thing I had was a sackful of hard boiled eggs. I handed her one and she looked at it quickly, then slammed it down on the ground and smashed it to bits. She then said to me in a very mean tone of voice, "Me Masai, no eat eggs, want shillings." This stirred up quite a commotion, so the bus driver herded the people together and we made a real quick QSY from there. You see, you might get in trouble even trying to give something to someone. We continued on our way and, when stopping time came, the bus driver would dump all the passengers out of the bus except me, drive me to one of the English tea rooms, drop me off, then go back and pick up the others and then come and pick me up. You know, I have been thinking, and I don't believe I ever did give that bus driver the few extra shillings I owe him for slipping me into the first-class section.

We passed right near Mount Killimanjaro and it's a real surprise to see a real big mountain covered with ice and snow in the middle of Africa. For any of you chicken-hearted fellows, I strongly suggest you make this trip because it will toughen you up. It is not exactly like a Greyhound trip from South Carolina to Washington.

Upon arriving at Dar-es-Salaam there was a customs inspection and VQ3PBD (Peter Dobbs) met me there and all he said was "this is a friend of mine" and that was all there was to it. Peter took me out to his house on the outskirts of the city where I met his wife and little family. I got on the air at VQ3PBD and had some very fine contacts with a few of the boys in the States. After a few days with Peter, time came for me to leave for Zanzibar.

The flight from Dar to Zanzibar was less than 20 minutes long, and when I arrived there a customs fellow came over to me, and all I told him was "I am a friend of Peter

Dobbs." It was open sesame and there was no inspection at all. You see, Peter was the head of the Tanganyikan customs and evidently well known even in Zanzibar. I bet things are not that easy over there these days. We went down to the Director of Radio and were issued our licenses very quickly. I got VQ1A and the VQ3 chap from Dar-es-Salaam got VQ1B and we went to a small hotel, put up our antennas and we were on the air in just a matter of minutes. Conditions were reasonably good, even 10 meters opened up a few times to the USA. Some 4 or 5 thousand QSO's were made in a little over a week's operation. VQ1B had only one weekend to spend there, so he departed and I stayed for another week. I walked all over the city, and what a puzzle it was with all those very small zig-zag streets. I visited many small shops and bazaars and picked up a few curios at very good prices. I also visited many of the workshops making ivory carvings, some taking months to make those long elephant bridges that are made from a whole elephant tusk. Some of them were 5 or 6 feet long, with a whole row of elephants in a line, each one holding the tail of the elephant in front. These were out of my pocketbook range, but it was very interesting seeing the very simple tools they used—only a small hammer, a few small chisels, an old beat-up file or two, an old hacksaw blade and a few pieces of sandpaper. It's a very slow process and requires a steady hand. One slip and the carving is ruined, but these fellows did not slip. Many Arabian dhows were seen at anchor being loaded to carry cargo back to Muscat, Aden, Saudi Arabia, etc. These dhows, I was told, would stay there until the southeast monsoon started and then go downwind all the way up the coast of East Africa to their destinations. They are very tough-looking ships and their crews looked the same. Zanzibar was one of the most interesting places I have been to. When it came time to leave, to the airport I went and back to Dar-es-Salaam where Peter Dobbs again met me. I spent the night with him and his family and early the next morning I was away on that African bus for Nairobi. I must have been a glutton for punishment. The return trip was about the same as the trip down, but more so. The same assortment of wild animals here and there and the same assortment of people on the bus, and even the same smell. Wouldn't it be nice to go down there along with Wayne Green, Al Hix, Howard Wolfe, and Enos W4VPD and go on a DXpedition on top of Mount Killimanjaro?

Back in Nairobi I spent a few days with George, who was then VQ4AQ, later 5Z4QT and ZS6? Everything was repacked, some things discarded, and I was away to Mogadiscio, Somilia, and the usual battle with customs began. They would not let me take the radio gear away from customs. Away I went to their Director of Telecommunications telling him all about my study of radio propagation, and I ended up with a note for their customs telling them to release my equipment, that he would be responsible for it departing with me when I left. I got my gear very quickly then!

I went to the highest hotel in town (sort of a small version of the Waldorf) and explained to the manager that I had to put my little aerial on the roof. All I had then were horizontal antennas which require poles. I had to find some poles, which I did and back to the hotel I came with them and right thru their real fancy lobby I barged. These poles were about 40 feet high. I bought 4 of them from a sort of lumber yard. Needless to say there was a lot of confusion and excitement when we came through that lobby dragging our poles across their wall to wall carpet, almost knocking down a big crystal chandelier. Luckily the hotel manager could not speak much English so we just kept on going while he was trying to tell us something. In all the confusion we got the poles thru the lounge and then up to the roof which required snaking them around the elevator shaft up about 7 floors.

All this time I had a young fellow with me who acted as my interpreter, a good investment at a lot of places. I was assigned the call sign of 6O1AA and the QTH was very FB, good signal reports. I tell you fellows when you want some good solid comfort get yourselves a real nice air conditioned hotel like this and all you do is sleep and operate. It makes a big difference in your performance on the air. This is the kind of DXpediting I like, but try finding such things in the really out of the way places. All I can say about the 6O1AA operation was it was a real lark all the way. Meals in this hotel were about $3.00 each, but with the assistance of my interpreter I got the same meal at a small restaurant for about 75 cents. The day came to depart and I was faced with the problem of those poles on the roof. My solution was very easy—we just threw them from the roof and let them stay where they landed—plenty of people wanted them for stove wood. I was afraid the hotel manager would have heart failure if we came back thru his lobby. Sometimes it is easier to get a license to operate than it is to get permision to put an antenna on the roof. On later DXpeditions, thanks to Hy-Gain and their 14AVS and 14AVQ verti-

cals, this problem has been pretty well solved and you have 4 bands in one place with a good SWR, and don't kid yourself, they do work! They made up one for me in shorter sections and it all goes in a small canvas bag 3 feet long and weighs about 6 pounds. It's and FB antenna for DXpeditions and goes up in just a few minutes. I use only 2 ground plane wires cut for each band I intend to use and the SWR is less than 1:1.5 on each band, which is pretty doggoned good for such a simple thing to install.

My next target was Djibouti. To get there from Mogadiscio required first going to Aden and getting on another plane and flying back to Djibouti. It always happens that you have to spend from one to three days in Aden to get a connection for this flight. This gives you a chance to see some of Aden and area around it. This is a very desolate part of the world, very little plant life, desolate-looking black mountains with no trees or anything else growing on them. To me they sort of look like, I suppose, the moon may look when someone gets there to inspect it.

There is *always* a big argument with taxi drivers in Aden, even when you have a definite understanding about the charges. They are out to wring the last shilling out of you

and brother if you are not really a good man defending yourself you will get "took" every time. They don't use meters on the taxis, so it's just you and him. The best way I found to deal with them was to ask the hotel receptionist what the proper charges were for a certain trip and when the taxi got there you handed him that amount plus a tip and just walk away from him and let him holler that you owed him more. I have never heard of one of them calling the police yet.

If you want to buy something in Aden their prices are fine on everything since it's a free port. Be sure to do your buying on the days when no big passengerships are in port because on those days they go up about 20 to 25% and you cannot talk them into cutting below this figure. You can find anything in the world there: Japanse transistor radios, tape recorders, cameras galore, Kodak film, perfume, jewelry, clothing, shoes, and any kind of luggage you want. All I can say is Aden is quite a place, hot as blazes, Arabs all over the place, camels right in the middle of the city pulling their carts, Yemenis walking down the street with their loaded rifles and fancy native dress.

I met some of the RAF boys out at Steamer Point and even operated their club station for a few hours. I found that none of the new fancy buildings had an elevator that operated. Oh yes, they had elevators, nice looking, fancy ones, but they just did not work! Some Otis Elevator salesman should be able to really clean up there selling elevators that work.

After staying there a few days my fingers were itching to get on a key and I was glad to depart. The flight left about 10 AM—oh yes, you are wondering about the Aden customs—ha ha—there is nothing to them at all, they ask you if you have anything to declare, you say NO and that's it! They have never looked in any of my suitcases and I have now (this is Nov. 1965) been thru there about 10 times. I wish all customs were like Aden—it would be a real pleasure traveling around.

When you step off the plane in Djibouti you know you are in a spot that really has hot weather, and I mean HOT. It is located on the edge of a desert you can see it all around you and feel it in the air that surrounds you. After the usual checking of your passport and the examination of your health card then the next business at hand is your baggage examination. Now you TRY explaining to a fellow in English just why you are there with all that radio gear, and he only understands French. I had decided that when my equipment was stopped in customs anywhere along the way that I would just let them have it and keep it until I got a license and then maybe with this they would release it to me. This is what I tried to do there. They said they had no place there to keep it. It ended up with my taking it along with me to my hotel room. That's exactly what I wanted and this suited me fine.

There was only one hotel in Djibouti at that time that was air-conditioned, so that's where I checked in. The air-conditioner was one of those cold ones and it really did a bang-up job. I tramped to the local post office (there is only one there) and located the head man. I told him I wanted a Radio Amateur License. I gave the filled-in form to him and he told me to return the next morning. Back to my hotel I went with the sweat pouring off me. Even my shoes were soggy. I was told the temperature was 115 degrees. I hung around the hotel all day drinking Cokes, got out and did a little walking around, took a few photos. Rundy OD5CT was to meet me later on and do some operating since he was coming to that part of the world on business. That darn air-conditioner made my room like an ice box. I found that it was wired directly into the circuit and there was no way to turn it off. The windows were nailed down and I could not open them. So I put on the heaviest clothing I had, even a nice heavy sweater. The next morning I went to the post office where I got the license with the strange call of FL9. Then I had to go to the Governor's mansion for his signature before the license would be valid and then back to the post office to pay for the license (somethinglike $17.50!) When this was all taken care of back to the hotel I went, after buying two nice long bamboo poles for my antenna. With my previous experience I found it best not to mention the word radio when checking into a hotel, but simply to locate two of best bellboys and get them to help you with the antenna when you were ready. The poles were pulled up on the roof from the side of the hotel. There was a lot of scampering on that corrugated tin roof—and I mean it was a hot roof! We got a basin full of water to stick our feet in to keep them somewhat cool. The 40 meter dipole ended up across the street on top of a Chinese laundry. The family lived on the top floor which meant we had to go thru their apartment to get to the roof. I noticed that their apartment was really fixed up very elegantly, with tapestry all over the place and even a small built-in Bhudda worship temple. They insisted I have tea with them, which I did. It was that nice smooth

green type served with small and very sweet cookies. I made friends with the family and had tea with them almost every day after that. The man of the house could speak a little English, which helped a lot.

I had been told to notify the police when I was ready to operate and that they would have to inspect my station before I could operate. This I did. They came around 5 PM, looked things over and asked a few question, filled in a little form, had me sign it, and left, but told me to remember that the maximum power allowed was 100 watts. I did not question them if this was input or output. I just assumed it was output and I further assumed that this 100 watts was the difference between the reflected power and the forward power. I was using a rig that was capable of 175 watts output so I didn't worry about this part at all. I could see that the fellows I was talking to didn't have the faintest idea what it was all about. Conditions were fine, the band stayed open practically all night. My operating habits ended up something like this. I would start my operation each morning at about 5 AM and I would operate till the band leveled off at about 10 AM then hit the sack, setting my alarm for 3 PM. I got up then and stuck with the boys until the band went flat about 2 AM. Very little time was lost sleeping there. I forget the exact number of QSOs I had from Djibouti but I think it was some thing over 5000 during the 8 days or so I was there.

After I had been operating there about 5 days Good Ole Rundy OD5CT finally got there and was assigned the call sign of FL8ZA so I let him take over operations for a while. Now Rundy is a fine operator so don't misunderstand me, but Rundy at that time liked to operate transceive—right in the USA portion of the band. Well you know how the eager beavers are on a deal like this. I tried to explain to Rundy what was happening back in the States. This was on a Sunday afternoon back there so you all know how it is. To work the States and to do it properly the first thing to do, in my opinion, is to stay out of the "W" portion of the band—never get in there or you will be murdered in about 5 minutes. I think the best way is to take on all comers regardless of who they are or what country they are in and to use a non-directional antenna (vertical) (then you can't be accused of pointing your antenna at the USA all the time by the Europeans or VK's). Work them all until you have the pile up whittled down to something you can handle. Tail-ending—sure I love it when it's done right, quick short ones—only *after* the report has been sent. The longest conversation I want on SSB is, "Hello Gus, Q5-S9 W5?? break". If I want to rag chew, let *me* start it. Don't send my call boys (I know it) just your call sign and then a BK.

Away we went back to Aden. Rundy and I had to stay there 2 days to catch a flight from Aden to Bahrein. If you want to see how the moon will look to the first fellows who get there, just fly from Aden to Bahrein. You will see some of the most desolate scenery below—those big black mountains with no trees, and the valleys look as if they are filled with black dust—and I have heard that's exactly what it is. Rundy said that if the plane ever had motor failure over that part of the world he would cut his throat just before the plane hit the ground. He said even if the fall did not kill you the dust would strangle you anyhow, and if this did not happen then the Bedouins would get you. So either way your number was up. I am glad to say the old DC-3 made it all OK and neither Rundy nor I had to use our knives.

Let me tell you about those countries on the Persian Gulf from Kuwait to the Muscat. To go to these places you have to have a police permit from each and every one as well as a sponsor in each place. This sponsor must be "in" with the local authorities—luckily Rundy had the connections and had this arranged beforehand for us, or we would never have been allowed to even leave Aden for the Persian Gulf countries. Getting licenses there is very simple—you just produce your W license and they hand you licenses for all four of the MP4 spots. We met the Big Bad Wolfe —MP4BBW Ein Cable out at his house and saw where all that signal comes from. The equipment was set up at the "Speed Bird Hotel" and I was on the air signing MP4BDE and had quite a ball for a few days. Bahrein is very prosperous looking place, plenty of big cars, the stores seemed to be doing a good business. There were a number of big oil tankers out at the docks filling up. You could see this was an oil town. Everyone seemed to speak English so there were no language troubles at all. You know it's a funny thing but after being in these places like Djibouti, Aden, Bahrein etc,., with all their hot weather after a while you begin not to notice it's so hot. I guess they know it's hot and that it will stay hot so that they just ignore it completely.

Time came for use to leave and we got all set to QSY to MP4Q. We were heading up the Persian Gulf and to me this was going to be interesting. Well this is it for this month boys, see you all next month. . . . Gus

Ralph Hanna W8QUR

Power Supplies

The trend in power supplies over the past several years cannot go unnoticed. The most interesting thing is the great reduction in size. What has brought about this big change? The first thing is the silicon diode or rectifier. This device has many advantages over the tube type rectifier. The small size is very important. This feature allows for less chassis space being taken up by the power supply. The high current handling ability, of course, is important too; an ordinary one will carry ¾ of an amp. These little rascals don't get very hot either. This is real nice when used in a receiver since the vacuum tube rectifier generates a terrific amount of heat. Here now is one of the big items in reducing the size of a power transformer, the elimination of the rectifier filament winding. The elimination of this item will give a considerable size reduction in the windings on the transformer as well as the core size.

Since silicon rectifiers are small in size and low in cost, it naturally follows that many manufacturers would go to voltage doubling, tripling and even quadrupling. At first it would not appear that this would be any advantage because the wire size would have to be increased for the same watts output. The saving comes in the fact that there are less turns, therefore less insulation. Then because of the lower voltage, the insulation can be much thinner.

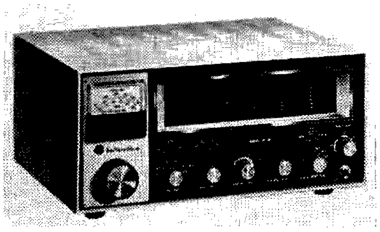
If you are building up a power supply, take a look at old TV transformers. These jobs are real good and one rated at say 200 MA at 400 volts can be made to run an amateur transmitter at 200 to 300 MA at 800 volts by bridge rectification. This is easy now because you don't need three filament transformers. Someone is going to ask how the 800 volts at 200 MA is accomplished from a transformer rated at 400 volts and 200 MA. The secret is the fact that we do not use the rectifier filament winding so do not have that heat loss and that the usual amateur service is intermittent and the average power is much lower than the 160 watts. It is not recommended that the full power be consumed, like when tuning up, for more than 5 minutes.

Many of the radio stores have bargain rectifiers rated at 400 volts PIV. This means that you should not run more than about 280 volts AC on this unit. A 600 PIV or 800 PIV rectifier gets quite expensive, so the best bet is to double up and use two of the 400 PIV units in series to get 800 PIV and about 560 AC volts.

When using the rectifiers in series, it is recommended that parallel resistors be connected across the individual rectifiers to divide the voltage equally across each rectifier. In some cases capacitors are also recommended. In spite of these recommendations, many commercial units use the diodes in series without either resistors or capacitors.

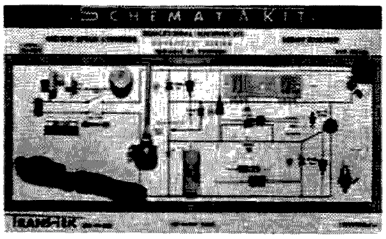
. . . W8QUR

NEW PRODUCTS



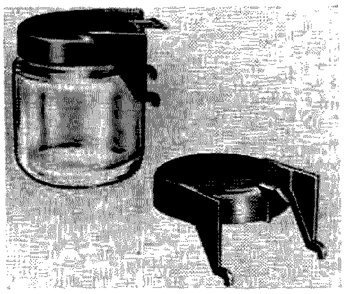
Hallicrafters HT-46

The new Hallicrafters HT-46 five band transmitter provides 180 watts PEP input on SSB and 150 watts on CW. It's designed as a companion to the SX-146 receiver and may be used independently or interconnected with the SX-146 for transceiver operation. The all-new HT-46 covers the five HF ham bands in 500 kc steps and the signal path is single conversion using a 9 mc crystal filter. The built-in power supply is solid state and unwanted sideband and carrier suppression are better than 50 db. Ham price is $349.95 and the accessory VOX adapter is $37.85. You can get complete specs from Bernard Golbus at the Hallicrafters Co., 5th and Kostner Avenues, Chicago, Illinois 60624.



Trans-Tek

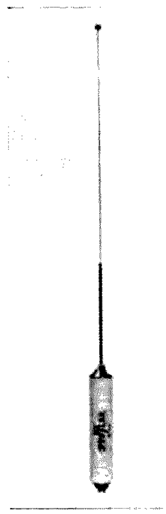
Trans-Tek is making some very inexpensive kits that will interest all hams for themselves and for youngsters with an interest in electronics. Each kit is clearly and attractively packed and uses modern solid-state components. The kits are: Metronome, $2.25; Code Practice Oscillator, $1.79; Hi-Lo Switch for lights and small motors, $1.79; Hi Lo Switch for larger motors, up to 500 watts, $2.49; 6-12 Volt Regulated Power Supply, $5.75; Intercom Amplifier, $5.95; Ultra Hi Gain Amplifier, $5.95; Variable AC control, $7.50. You can get more information from Trans-Tek, Garwood, N.J.



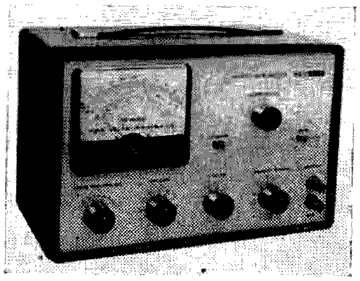
Handy Dandys

Any ham who has puzzled over a good, inexpensive way to mount the ubiquitous baby food jar full of parts will be very thankful to Wickliffe Industries. They're making a very inexpensive gadget that mounts on pegboard to hold your jars. It's called the Handy Dandy. Everyone seems to have plenty of the jars or can get them easily, so this may be the solution to your problem of storing and separating small parts. Price is very low. A sample of 12 is $1, 3 dozen are $2.50, 6 dozen are $4 and 500 are $25. Wickliffe Industries, Wickliffe, Ohio.

New-Tronics Super Hustlers



New-Tronics' new Super Hustler line of high frequency antenna resonators can handle the legal limit on SSB. They're designed for wide-band characteristics and each of the unique coils is wound with wires containing 413 individual conductors insulated from each other. Impedance is 52 ohms at resonance without matching devices or line pruning and there is minimum frequency drift from heat. The Super Hustlers are designed for use with standard MO-1 and MO-2 masts and accessories are available. Jim Taylor, Newtronics, 3455 Vega Avenue, Cleveland, Ohio 44113, can give you more information.



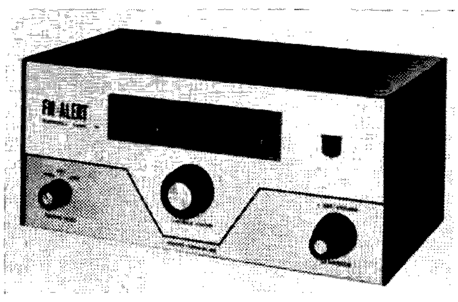
Eico Audio Generator

Eico Audio Generator

Eico's just introduced a new low distortion, wide range, high output audio generator that provides switch selection on any frequency from 1 cps to 110 cps by cycles. Frequency accuracy is 5%. The output has less than 0.1% distortion from 20 cycles to 20 kc and is metered with a large meter. Price on the Eico 378 is $49.95 in kit form or $69.95 wired. Get more information from your local Eico distributor or from Eico, 131-01 39th Avenue, Flushing, N.Y. 11352.

Panel Signs Transfers

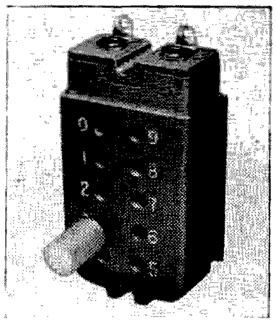
The Radio Constructor, an English popular radio magazine, sells some panel signs similar to decals that will interest many of our readers. There are four sets: 3, White wording; 4, Black wording; 5, dials with clear backgrounds; 6, dials with black backgrounds. The dials can easily be calibrated, too. Price is a reasonable 75¢ apiece, or all four for $2.75. Best way to pay is an international money order. Data Publications, 57 Maida Vale, London W9, England.



Squires-Sanders FM Receiver

The new S-S FM Alert emergency receiver features two crystal controlled channels as well as variable tuning. It comes in two models: 152 for 152-175 mc, and 30 for 30-50 mc. The FM Alert offers excellent performance, convenient operation and versatility. Squelch is provided for easy monitoring. Price is only $89.95, with a separate matching speaker available for $9.95. You can get more information from Squires-Sanders, Martinsville Road/ Liberty Corner, Millington, N.J. 07946.

Clarostat Decade Boxes

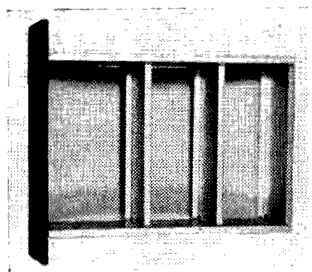


Hams who experiment like to have quality decade boxes to use, but most of the ones available are pretty expensive. Clarostat has just introduced a series of new decades they call "Claro-Dec's" in the range of resistances from .1-.9 to 100 k 900 k. Each one costs only $3.95. For a brochure on the Claro-Dec's, write to Clarostat, Dover, N.H.

EZ Mobile Antenna Mount

The EZ Mobile Antenna Mount is a very clever, inexpensive way to mount your mobile antenna without poking holes in your car. EZ Mount says it will support any antenna on the market at any speed. The mount is made of double chrome coated stamped 14 gauge steel and mounts quickly on your trunk lid for better radiation characteristics than you get with bumper mounts. There are three models: C-375 for antennas requiring ⅜" holes, C-750 for ¾" and C-103 for ball mount antennas. Price is $8.95 postpaid. Mounts or more information are available from EZ Mobile Antenna Mount, P.O. Box 277, Algonac, Michigan.

Devices



A new 73 advertiser, Devices, offers a simple, neat, easy-to-use method for constructing electronic equipment. They call it the unit Chassis. The basic Unit Chassis consists of a half rack panel 3½" high, and three 3"x6" subchassis. When these four items are assembled in the Unit Chassis, any one may be removed without disturbing the assembly. You have to try one to appreciate its convenience and time-saving. Cost is $5 from Devices, Box 136, Bronx, N.Y. 10463.

NEW BOOKS

Pulse Electronics

Not all that's interesting in electronics is to be found in the ham manuals. They tend to lack necessary detail, and don't give enough emphasis to transistor operation and circuits. Such shortcomings can be made up by working on a good book, and Littauer's *Pulse Electronics* from McGraw-Hill, 1965, is recommended.

This is a bright orange and white volume, full of straight-forward information valuable to users of modern electronics. It was written for research workers who need to be able to design useful circuits without spending time in electrical engineering courses. Its direct treatment will meet the needs of the advanced amateur beginning to detect some major gaps in his understanding of electronics.

An early part of the book describes the operation of transistors and vacuum tubes. This is followed by a section on choosing operating conditions. A later chapter will update the reader exposed only to cathode biasing. Constant current, feed-back, fixed and other types of biasing are discussed, along with views on drifts and aging effects.

Four basic kinds of circuit feedback are considered. Bet you never heard of three of them! Still another section describes methods for taming feedback circuits, which, in case you lack the experience, sometimes tend to take off at high frequencies. And there are several pages which will interest those with filter problems.

So it goes, through 530 pages. This book is not easy, but is probably a dark horse in the amateur literature market because of its treatment of modern electronics. Find a copy and see for yourself!

. . . James Ashe W2DXH

TI Communications Handbook

Readers who are seriously interested in improving their knowledge of modern semiconductor communications will want to get a set of the Texas Instruments staff-written *Communications Handbook*. It comes in two paperbound parts. Each costs $2 or you can get the set for $3.50. The books go into detail (including mathematical) on all applications of transistors and other semiconductors in communications. Practical details are also given. The book is available from TI distributors (including Allied Radio) or Technical Publications, TI, P.O. Box 5012, Dallas, Texas.

Transistor Circuits

Two books by Allan Lytel put out by Sams should be of interest to hams who like to experiment with semiconductors: The *Transistor Circuit Manual* ($4.95) and the *Handbook of Transistor Circuits* ($4.95). Each gives the circuit for many useful and interesting semiconductor devices. For instance, the first one includes chapters on basic semiconductors, switching and logic, counters, flip-flops, power control, timers, indicators, photoelectrics, controls, transistor power converters, audio amplifiers, rf and *if* circuits, transistor and diode oscillators, power supplies and regulators, radio and TV circuits, AM receivers, and special circuits. The second book has many similar chapters. Each schematic gives practical values. Either can be bought from your local distributor or from Howard Sams, Indianapolis, Indiana.

RCA Receiving Tube Manual

If you think that tubes are dead, you haven't seen the new 576 page RCA tube manual. It sells for only $1.25, a fantastic value, and gives you page after page of useful information: tube theory, applications, installation, CRT dope, VR tube information, testing of tubes, amplifier data, outlines, circuits and, of course, extensive information on all RCA receiving tubes. Pick up a copy at your distributor or from Commercial Engineering, RCA, Harrison, N.J.

RCA SCR Experimenters Manual

Silicon controlled rectifiers (SCR's) are very useful semiconductors that are much used in switching, rectifying and control circuits. Among other applications familiar to hams, they are used in variable speed electric drills and make it possible to slow the motors down with little loss of power. RCA has come up with a fairly inexpensive kit of semiconductors for SCR experimenting and an excellent manual to go with it, the *RCA Silicon Controlled Rectifier Experimenter's Manual*. The book gives instructions that are easy to understand and use in making a lamp dimmer, motor speed control, electronic timer, time delay, flasher, battery charger, model train or car speed control, light operated switch, heat controlled switch, overload switch and electronic synchronous switch. You can have a lot of fun with this book. It's only 95¢ from your distributor or RCA Commercial Engineering, Harrison, N.J.

advised by my lawyers that
don't you ever proofread y
are a bunch of crooks and
this is the last straw for
have no other recourse but
should be tarred and feath

Letters

Wayne Green

Dear Sir:

Would suggest that you make some arrangements with a good university to—will—your brain? to them . . . at . . . death. So that through scientific research (an operation could be studied and then performed on children—to prevent a recurrence of the kind you apparently possess).

Dr. H. B. Cully WA8CPA
Podiatrist
Van Wert, Ohio

Thank you. I hope you enjoy the subscription to Bambi Comics we are sending you in place of your subscription to 73. . . . Wayne.

Mr. G. C. Bandy, KL7CVB
P. O. Box 840
Delta Junction, Alaska

Dear OM:

We're sorry to hear that you do not intend to renew your membership when it expires at the end of this year. Management can but follow the orders of the elected directors, who are charged with the formulation of League policy on all important matters. The directors in turn are elected from among the members of the League in the various divisions and they serve for two-year terms. It would appear that should the directors not follow the wishes of the members, then they would not be reelected at the next balloting. As a member, you have had the right to help nominate a candidate or stand for election yourself, and to keep your elected representatives informed as to your views. As a non-member, you would no longer have the right, and yet still would be influenced to some degree by the League's future course.

Though the Headquarters staff had no voice in determining the League view toward incentive licensing, I was present at the Board meeting, and would be happy to comment on any points which disturb you particularly. To that end, I enclose an envelope you could use for this purpose. 73,

Sincerely yours,
Perry F. Williams, W1UED
Assistant Secretary
ARBL

Mr. Perry F. Williams
American Radio Relay League
225 Main Street
Newington, Connecticut

Dear Mr. Williams:

Thank you for your letter of December 16th in regard to my termination of membership in ARRL.

During the past two years I have stated my reasons for opposing the so-called incentive licensing plan in letters to ARRL headquarters, FCC and Senator E. L. Bartlett; copies of my correspondence with both FCC and Sen. Bartlett were also forwarded to ARRL headquarters; a copy of my formal submission to FCC in opposition to the proposed rule-making also was sent ARRL headquarters; therefore I will not go into detail on the matter but if you are interested and so desire I would be glad to send copies to you.

I understand how the board of ARRL is elected, and that management supposedly follows policies laid down by the board who in turn are guided by the wishes of the electorate. In my own opinion, and in the opinion of a very large and ever increasing number of ARRL members, is that something is very odd about the actual practice in view of the actions of board and management over the past two years. Many are finding it rather difficult to believe the rank and file members have anything at all to say about League affairs unless it happens to be in agreement with management and board. In short, confidence in ARRL has decreased; there is no longer the pride in being a member when you suddenly realize you are no more than a name on a subscription list. That is a hard statement to make, but I fear a great many members feel that way as I am sure your membership list will show.

This situation did not come about entirely because of the incentive licensing plan; had the League used a more moderate approach the plan may have gone through, and been accepted by members. But the arrogance of the initial editorial on the subject, the deaf ear turned to each and every member throughout the affairs and the somewhat gloating attitude when FCC made their proposal, all combined to create resentment that will take a long time to die.

My personal concern with the proposal was the effect on emergency operations; the ARRL proposal RM499 would have virtually eliminated Alaskan emergency operations, and the FCC proposal would mean the loss of flexibility to an alarming degree. I have been in radio communications for more than 20 years; and I cannot believe the benefits to amateur radio to be derived from the proposal can possibly compensate for the damage that will be done to emergency communications, especially in this state where distances are so great and where in so many instances in the past the radio amateur has contributed so much public service, saved so many lives and was indispensable so many times.

The failure of ARRL to consider the effect their propoasl would have on emergency communications was a very serious mistake. To those of us who consider amateur radio a public service first and a hobby second, ARRL has shown a lack of comprehension of the value of emergency communications that is alarming in view of their past influence with FCC. That influence, however, along with the prestige of ARRL has apparently decreased to an all-time low during the past year.

In reading the "Letters" section of QST it was noted that almost all letters published were in favor of the proposal; the opposition letters were selected apparently for their poor taste. It is inconceivable that this was a fair sampling of letters pro and con received on the subject. Nor do I recall one single article written for QST on the subject that did not follow the same ARRL line. If QST is the house organ of ARRL, "by and for amateur radio", would it not be reasonable to assume that those members opposing the proposal should at least have a chance to express their views in a sane, dignified manner?

In summary, my decision for terminating my membership in ARRL is the result of two years of thought on the matter; I hesitated last year, finally decided to try one more year in the vain hope the policies of the League would at least return to a consideration of all segments of amateur radio. Since that has not happened and is not likely to happen in the forseeable future, and since the prestige and influence of ARRL is steadily declining, I must allow my membership to lapse at the end of this year. It is my intention to continue working for amateur radio and in particular for the public service segment; the satisfaction in rendering assistance when it is needed means a great deal more to many of us than a prestige license or call sign.

Thank you for this opportunity to explain my reasons for terminating my association with ARRL.

Yours truly,
G. C. Bandy KL7CVB
Delta Junction, Alaska

Dear Wayne,

Eico puts in a nice big ad on their 753 and you put in one of those sterile, uninformative, "it's lovely" type of reviews. This article just doesn't do justice to the Eico.

Jim Feeney WA6CLZ
Orangevale, California

Most of our "test" articles are written by fellows who have bought a piece of equipment and like it well enough to tell everyone else about it. Most of our writers are average everyday hams, not technical geniuses trying to show off their erudition and thus you'll find equipment evaluated from the viewpoint of the user rather than the engineer. It is nice when a company makes an engineering coup, but often this is lost on us when the gear turns out to be miserable to operate. At any rate, let me repeat again, if any reader buys something new and feels that it is great enough so everyone else should know about it then let us know that you'd like to write it up and if no one else is ahead of you we can give it a try. . . . Wayne.

Dear Wayne:

I would like to suggest a little fodder for future editorials, since it looks to me like very little attention has been paid to the future of ham radio when, to my way of thinking, several interesting and perhaps dreadful possibilities lie ahead. To wit, the following questions:

1) Will the increased use of satellite and LASER communications open up more HF frequencies and relieve the pressure on the ham bands?

2) Will more sophisticated means of communications now in developmental stages actually constitute more of a threat to our VHF assignments than our HF assignments in the long run?

3) If, as Robert Sarnoff is fond of saying, in 20 years every person on earth will have his own private telephone which he will carry with him at all times (ála Dick Tracy) and every newborn baby will be issued a telephone number as he is born, what will be the role of amateur radio?

Of course, nobody knows the answers, but the possibilities are interesting to contemplate.

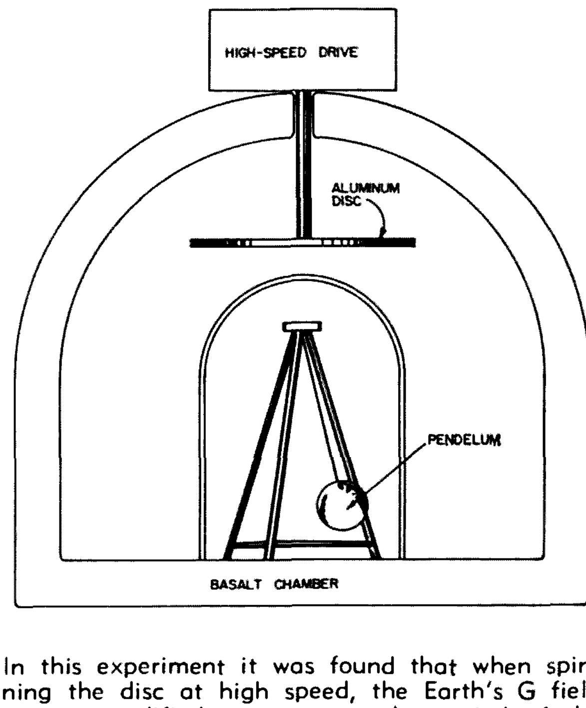
Fred Laun W9SZR
USIS, Caribbean Area

Niue Island
4 January, 1966

CORRECTIONS

The article on the regulated power supply on page 34 in the December issue has an error in Fig. 1. The 12 and 24 v positions of S2B are reversed.

W9SEK also says that difficulty with Q2 oscillating in the transmitter on page 8 in December can be corrected by replacing the .01 μf capacitor at the cold end of L2 with a .1 μf one.



In this experiment it was found that when spinning the disc at high speed, the Earth's G field was so modified as to cause the period of the pendulum to change. This experiment was performed at Franklin Institute. W8VHH.

Dear Wayne:

I have never read your column once, but the letters UFO can't be missed, so I read the January column from stem to stern. You hit the UFO problem on the head except for the method of propulsion. You will find that a gravity field has a fixed propagation time.

Robert Pielage W8VHH

Dear Wayne,

I am not a licensed ham because of my attitude towards the CW-FCC ruling. I don't like any part of CW nor the frequency allocations set aside for same, nor the fact that most licensed hams can't and don't use it.

How about more articles for the SWLs and less about Xmiters and amplifiers.

More power to you and your mission.

S. M. Irwin
Fresno, California

Dear Wayne,

I enjoy your articles very much and agree with you on ARRL has done in the past and what the future looks like. I've been a member of ARRL for seven years only because I want to read the DX Column in QST. You should have a DX section in 73 to keep 73 growing.

John Shope KØTRG
Kansas City, Kansas

We'd love to have one if we could only think of some new approach. The column in QST seems awfully dull to me and I'd hate to strain hard and come up with a similar one in trivia. I've been talking this problem over with KV4AA, W6KG, W4BPD, and other top DXers and may soon have something interesting to report.

Dear Wayne:

I just finished reading your January editorial. Reads fine all the way. As regards your policy on articles when accepted, let me say thanks for the check I received last week for the article that I sent you three weeks ago. As regards how long it takes to get into print, my article about the Florida style tower in the November issue was paid for in mid 1964, again just about three weeks after I sent it to you. I got more to read in the January issue for 50¢ than you get in that other one in three months for 75¢ a crack, and better reading at that.

Earl Spencer K4FQU
Fort Myers, Florida

Dear Wayne:

With reference to the personal static you reported in your January editorial, and recallling some of the things I've read about you in other publications, deponent states:

There is one untruth quite a few of us can expose. No one would believe that you could regularly offer us the work of a writer like Jim Kyle, for example, unless you paid well and promptly and published a magazine he could read without chagrin. So I suppose the charges of non-payment refer to the bulk of your contributors who, like myself, afflict you with manuscripts spasmodically (and write the same way). As one of these I can affirm that you have always paid on acceptance and in amounts nicely calculated to leave me with a slight feeling of guilt. To confirm a point you made I can add that on one occasion you published a contribution a year after I had spent the money received for it. I thought you had lost your nerve. Incidentally, don't fret about that sense of guilt—I can bear it.

As an Extra Class Gadfly you are certain to be swatted now and then as you probe sensitive areas, so I hope those amateurs who occasionally find themselves in agreement with your policy on specific issues will help generate a true concensus by signaling their approval with a letter.

A check for $3.00 for a 1966 binder is enclosed—this doesn't indicate I think you'll last out the year, it's just that I'm burdened with an orderly mind.

Ken Cole W7IDF
Vashon, Washington

Dear 73:

Mr. Eric Young's solution to the identification of amateur stations in January 73 p. 89, operated by persons other than the licensee is unusable because amateur operators do not carry call signs. Neither does a broadcast station disc jockey, engineer, announcer, owner, program director or any other individual have a call sign. Radio STATIONS have call signs. An amateur operator has a license but not call sign is associated with any individual. If you don't believe this get someone to apply for an operator license without filling in the blanks pertaining to the station. He will receive an operator's license with no call sign as I did on my first license when I had no permanent address and used Navy MARS Station rigs.

James Stuckey W5ZJO
Baton Rouge, La.

Dear Wayne,

I have a couple of comments about the editorial in the January '66 edition of 73, starting with a short lecture on *force*:

Electromagnetic forces (e.g. the coulomb force) are created by the exchange of photons and virtual photons between the two particles involved. Nuclear forces are due to the exchange of pions (pi-mesons) and virtual pions. (Nuclear forces are the short-range forces which hold a nucleus together despite the repulsive coulomb forces acting.) Similarly, people have postulated a particle, generally called a graviton, whose exchange leads to gravitational force.

The nuclear force can be described by the Yukawa form

$$F = \frac{F_o}{d^2} e^{-md}$$

Note that there are two parts, an inverse square part F_o/d^2 and an exponential e^{-md} which becomes very small as the distance between the two particles gets larger, and gives the force its short-range character. In this formula, m is the mass of the exchanged particle, a pion, usually written mff.

In the case of an eletcromagnetic interaction, the exchanged particle is a photon, which has no mass. There is correspondingly no exponential term in the force formula, and we are left with the pure coulomb inverse-square law, $\frac{F_o}{d^2} = \frac{kqq^1}{d^2}$

Presumably, since gravitational forces are also inverse-square, the mass of the graviton is zero. This, however, doesn't exempt it from the requirements of relativistic mechanics, which work in every case we know about. One of the requirements of the relativistic formalism which has been developed is this: in order to avoid an ambiguity in cause-and-effect, i.e. to eliminate the possibility that in some frames of reference an effect happen before its cause, we must require that, even in theory, no interaction propagate at more than the speed of light. This would apply to any interaction, even to interactions caused by massless particles like the photon, the neutrino, and, if it exists, the graviton, because it is not derived from the mechanics of an interaction. It is derived from the nature of space and time, as we know them, and the requirement that "if A causes B, then A must occur before B"

Further comment: I disagree with your statement that "We have no real idea of what it is that goes to the moon and bounces back . . ." etc. We understand light waves, or photons, or whatever you want to call them, as well as we understand anything else in physics, and a lot better than we understand any of the elementary particles which have mass and charge. Strictly speaking, I admit, we don't undrestand *anything*, but I think that it is misleading to say it the way you did. Certainly no one would say he didn't know what a moon-rocket was, although he may not understand the detailed mechanics of its operation.

Further comment: K1CLL was wasting his time, unless he was using a microscope to watch his antenna. Let's figure the force reacting on the antenna due to the 100 watts leaving it. Suppose that the entire signal went out in the forward direction, so that it was all pushing the same way. In one second, the energy sent out is 100 joules, since a watt is a joule/second. The momentum of this 100 joules is momentum $= p = mc = \frac{E}{c} = \frac{100 \text{ joules}}{3 \times 10^8 \text{ m/sec}}$

$$= 3 \times 10^{-7} \text{ kgm/sec in one second.}$$

The force due to to this radiation is:

$$F = ma = \frac{m\Delta v}{\Delta t} = \frac{\Delta p}{\Delta t} = 3 \times 10^{-7} \frac{\text{kgm}}{\text{sec}^2}$$

$$= 3 \times 10^{-7} \text{ newtons}$$

Now suppose that K1CLL hung his beam from a 50 foot wire, and that it has a mass of 10 kg, that is a weight of 10 kg x 9.8 m/sec² equals 98 newtons. This means that the beam will want to be in a position slightly displaced from the vertical. We can calculate the displacement from similar triangles to be 10^{-6} inches.

Just by turning on his rig, K1CLL created a pendulum swinging around a new equilibrium point with an amplitude of about a millionth of an inch. Even if he had keyed the

thing just right, in step with its oscillations, the way you push a child on a swing, I doubt that the Q of such a mechanical system is more than 10,000 so he couldn't have got an amplitude of more tan a ten-thousandth of an inch.

Thus, your statements are correct—the beam didn't move a hundredth of an inch. But your conclusion, or at least your implication, is completely wrong.

Incorrect statements like this cast a shadow on the rest of what you say. Still, you're making hams think, which is more than most of them would do otherwise. Keep it up.

Roger Chaffee W1IQQ
Berkeley, California

Dear Wayne:

Re your editorial in January 73—I have been waiting for some time for some interest to develop in the direction of using gravity as a means of communication. Your article will probably cause several letters to be written as I am reasonably sure that there has been enough evidence collected to show the possibilities of that system or mode or whatever you want to call it. Now, I am not interested in going into the UFO angle at present, but what I would like to see is the possibility of using your magazine as a sounding board and central collection agency for tests, experiments, and descriptions of models—or even some speculative articles on ways and means of using gravitational forces as a communication medium.

In 1959, while working with a three axis accelerometer for an inertial navigation system it occured to me that some of the effects noticed while two similar systems were operating adjacent to each other could be attributed to gravitational forces and that the system did provide communication possibilities—and further, of course, provided a method wherein the velocity of propagation of the "wave" could be measured. Incidently, this accelerometer (one I developed) was sensitive to the category of 10-10g. I wrote a disclosure on the effects noticed and attempted to describe the mechanism involved: in particular, a description of the variation of gravitational forces under dynamic conditions as compared to static conditions and certain other intuitive feelings concerning equal masses in the systems (possibility of resonance), etc.

I did not send the disclosure to the patent office or attempt to do anything with it at that stage. I perceived that I probably had not accurately described what I had observed (terminology yet to be developed) and further that even if the system were patentable the time delay between discovery and actual practical reduction to practice would probably exceed the life of any patentable protection.

It occurred to me that there was an analogy possible between the development of a gravitational "action at a distance" system and that which has occurred in electro-magnetic technology. It also occurred to me that radio amateurs would be the best developmental team approach to reduction to practice. I can see a parallel, for instance in the old coherer and silver filing detectors as compared to the detector that I used. In many of the early electro-magnetic experiments the helpmate of resonance was not used although it is probably fortunuate that Hertz did have resonance of sorts with the spark gap supporting rods used on his leyder jars. (Hertz's system was probably resonant around 250 mc)—and there are of course, the esoteric teachings of Nikola Tesla in regard to resonance.

I can fill many pages with further information about the possibilities of using the gravitational approach, but before I rave on I feel I had better wait for an answer from you as to how you feel about these things. The articles you could or would publish (at least initially) would have to be carefully worded so as not to alienate your present audience or cause unkind comment about the condition of your mental faculties.

Incidentally, I have no intention of attempting to patent this system or concept. I just think it would be fun to watch the development, especially by radio amateurs, whom I hold in high regard for their practical research abilities.

I am prepared to write a lead article going into detail about the possibilities—and then several articles on construction of simple equipment to verify the effects that I have observed—and then the door is open if a few of the guys will pick it up and help develop—are you interested?

W. E. Barker Jr. W4YGT
Gainesville, Florida

Sure. . . . Wayne.

Dear Wayne:

As a loyal ARRL member I usually find your editorial rather disagreeable, to say the least. Not so in your January issue, however. Your discussion of UFO communication, etc., has filled a void that has long existed—serious consideration of UFO's in a national magazine. As you have probably guessed, I am a firm believer in them. However I would like to take issue with one point you made. You seem to take the view that we should not "let them know what we know about them." You then made the statement that this subject should not be discussed over the air. It is my belief that the very fact that UFO's have apparently been visiting our planet for hundreds of years shows that their intentions with us, if any, are peaceful. I think they want us to know they are there, and their increasing frequency of visits is a way of getting us used to seeing them. I suggest, therefore, that instead of keeping quiet on the air, we should make it a point to let them know that we are interested. In effect to say "if any of you guys up there are reading the mail, drop down for a visit." Who knows, a ham may establish the first recorded "QSO" with an UFO.

Craig Smith W2BHP
Endicott, New York

Dear Wayne,

Somebody's been reading "The Day After Tomorrow" (or Sixth Column) by Heinlein. (Or has John Campbell been ghostwriting your editorials?) Although I have never heard of the Biefeld-Brown effect, I would be interested in trying the experiment. One guess as to what the cause of the orientation change is is that the molecules and atoms of the dielectric exhibit a magnetic dipole moment as well as an electric one. If the effect disappears in a vacuum capacitor, this might be the answer. If it is still present, throw out your old textbooks.

The one physical fact that makes modern electronics possible is the charge to mass ratio of the electron. Because it is possible to exert an enormous force on an unbelievable minisucle amount of mass, it is possible to accelerate electrons by billions of miles per second per second. The gravitational "charge" to mass ratio so far as is known is one to one. If there is any electro-gravitic field radiated by an oscillating mass, it will be very, very small indeed if the two types of radiations are analogous in that they depend upon mass (or charge) and acceleration. Of course, they may not.

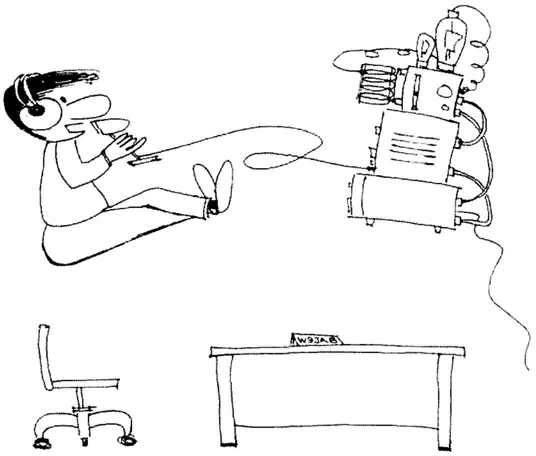
Then, there is the unexplained nuclear force, which over short distances is even more powerful than electric forces. If someone discovered how to radiate a field which microscopically changed nuclear interactions, it might be possible to communicate with such a field if it were possible to decode it. Since almost all experiments in nuclear mechanics deal with statistical methods, probably no one would notice if atomic characteristics were changing by miniscule amounts millions of times per second. Sound ridiculous? Everyone knows that it is impossible to generate a coherent light beam. (If I remember correctly, bumble bees can't fly either.)

Beginning of digression on your digression. If K1CLL had measured more carefully he would have found a force on the beam, assuming perfect reflection. The phenomena of radiation pressure is well known and accounted for. It is normally so small as to be measurable only under laboratory conditions. However, it has been proposed as a method of spaceship propulsion. In space, where there is no atmospheric resistance, a ship would inflate large "sails" of reflecting metal, place them between itself and the sun, and go sailing off into the star rise.

If you're in a bad mood, don't read the rest of this.

I'm ashamed of you for saying "Needless to say, this is something that you should not discuss over the air . . ." I feel compelled to launch into a passionate defense of freedom of speech but haven't got the time. Do you seriously think that beings who are capable of building devices which do what the UFO's have been reported to do rely on short wave radio only for intelligence data? And do aforementioned beings *need* intelligence data. I believe that we both believe that bureaucracies busily keep secrets from the populus more to justify the existence of the bureaucracy than from a real need to keep the secret secret. (Or to hide bungling). If you don't believe this, call up the local telephone company and try to find out the difference between a G1 and a G3 handset.

Richard Factor WA2IKL
New York, N.Y.



Now I know Wayne Green has gone nuts! In the January 73, Wayne said he expects hams will stumble onto the key to electro-gravitism!

Dear Wayne:

Actually, I am quite interested in electrogravitism, and would like to get hold of more information. While the so-called laws of gravity have been established for a long time, any physical explanation or definition for the gravity field has scarcely been touched on. And just as electro-magnetic waves were discovered and used before they were defined by physicists, it is possible that other types of fields and media will be discovered and used quite by accident by people who like to experiment for personal enjoyment.

I will be looking forward to any further information on these ideas in future issues of 73.

Paul Gihring W9JAB
West Allis, Wisconsin

(W2NSD from page 86)

Gus W4BPD with the usual Coke in hand at Miami.

haps we should set some sort of agreed limit on QSL's . . . say one dollar each. This way you can get your first hundred countries free, since there are at least one hundred easy to work countries. From then on you could figure on a buck a QSL. Shucks, it costs you $6 for a day of skiing, so why not $5 to work five rare ones some day?

In case there are some of you who have skipped my past editorials I suppose I should mention here that the above is intended to be sardonic. I think the whole idea of charging for QSL's is terrible.

The FCC seems to have a low threshold on their sense of humor where it comes to picking up a little dough from QSL's too. I note that you'd better be very clean if you intend to use your U.S. call with a portable designation. If you are using a DX call there isn't much they can do. Of course the secret to this whole problem is the acceptance of these operations as legitimate by the League. If the League put their foot down about paid QSL's then there would be no problem and no incipient FCC action, etc.

Perhaps 73 should take the tiger by the tail and demand some sort of proof from DXpeditions that they are actually where they say they are . . . photographs, documents, something . . . and then cancel any operation where QSL's or contacts seem to depend on contributions. This is suggested as an answer to the critics of DXpeditions, not as a criticism of them. With the exception of the CEØ trip I've gotten most of the QSL's for the DXpedition contacts I've made . . . and I haven't sent any donations. I'm ready to pay well for ar-

ticles on these jaunts and that'll have to do for me. For instance, if the CEØ story had appeared in 73 we would have paid about $120 into their kitty . . . maybe a lot more.

Of Small Note

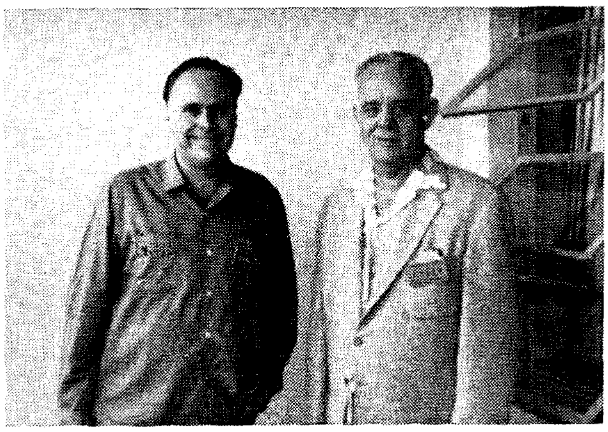
R. Lumachi WB2CQM has asked us to mention that the article in the November 73 by him was rewritten by us. We did rewrite it, extensively. We rarely have to do this.

Miami

The Hamboree has pointedly not been asking 73 down to exhibit for the last couple years. One of the officials got me aside and apologized, saying that they had orders from QST Headquarters not to let 73 in. Since this doesn't keep me away from the convention I expect that they are mostly afraid that 73 will sell a few more subscriptions and are trying to hurt us financially as much as they can. Pretty small potatoes.

Many fellows commented on the scant turnout this year at the Hamboree. I was surprised too. The old days when the manufacturers came down to exhibit in strength seems to be a thing of the past. The place looked deserted. This is a shame because Miami in January is certainly the right place at the right time.

I've been asking around, trying to get some idea of what is happening to ham conventions. Quite a number of fellows down in Florida that I've contacted on 20 meters said that the reason they didn't go is because they don't want to support a QST convention after the kick in the teeth they got on the incentive licensing proposal. I did note that only two of all the people I had a chance to talk with at the Hamboree were in favor of the proposals and many wanted to know where that

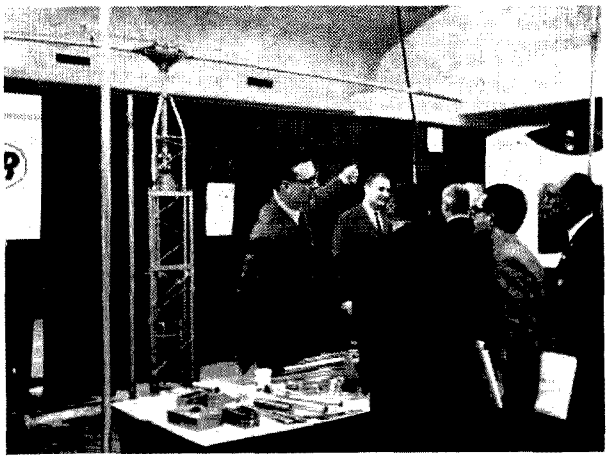


Wayne W2NSD/1 talks over DX with Wayne W4ZZV (HR2WC).

Paul WA1CCH goes over some VHF articles with Jay W4VTJ.

50% was that QST claimed supported them. They sure must be in hiding somewhere for they don't come to conventions.

We'll all be watching to see what kind of turnout they have at Dayton this year. This is the only big non-QST convention going. This may tell us whether it is conventions in general that are going out of style or just QST Conventions. And is there anything as dreary as a convention with no people?



Newtronics drew a smashing crowd, comparatively, with their Hustler antennas.

Boston

QST continues its economic embargo of 73 by insisting that 73 not be permitted to sell subscriptions at the Boston convention. It's OK if I come, but no booth . . . hi. I dunno . . . I called the hotel and they quoted me $55 for a room *per night*. Add that to the $13 for the convention and a big lump for parking my car and I would do better to go down to Bermuda for a couple days . . . and I would save money.

. . . Wayne

Caveat Emptor?

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★ We will be the judge of suitability of ads. Our responsibility for errors extends only to printing a correct ad in a later issue.

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COLLINS 32V1 transmitter, good condition, $75. Tecraft 6 meter converter with Tecraft power supply, $30. 5 element 6 meter beam CushCraft, 1 year old, $15. 11 element 2 meter beam CushCraft, new, $10. CDR TR-44 antenna rotor good condition, $30. Two surplus 432 mc UHF transceivers: 1 with AC supply and 1 with dynamotor, $15. A lot of other junk. Gerald S. Blanchard, Box 205, Hillsboro, N.H.

QSL CARDS: Samples 10¢. Quality—reasonable—fast service. Decals, rubber stamps, photo labels, log books or loose leaf. Malgo Press, Box 375, Toledo, Ohio 43601.

CANADIANS: HAMMARLUND HX-50, SSB, CW, AM with PTT, VOX. HQ-170A adjustable AVC, selectivity, notch filter, noise limiter, selectable sidebands. Write S. Ranti, 3465 Limoges, Montreal.

GOT MORE GEAR than I need. Transceivers, etc. Send SASE all inquiries answered. Kris Krysaik, P.O. Box 465, Sebring, Fla. 33870. Phone EV5-7353.

ATTENTION NEW HAMS: New complete ham station. Includes Eico 720 transmitter, Hallicrafters S-108 receiver, Eico 722 VFO, plus crystals, others. List $400. How about $250? Joseph Sanger WB2SSB, 22 Teakwood Lane, Roslyn, L.I., N.Y. MA 1-5158.

TELEVISION CAMERA. Vanguard model 400 less vidicon and lens, $75.00. RG-17 coaxial plugs $3 each. Jack Schmermund, 401 North Main Street, West Milton, Ohio.

ALL GALAXY Galaxy III, AC supply in speaker cabinet, external VFO, VOX, Rejector-All $340. Want SBE 34. No ship. W2GDZ, 212-VI 6-0396.

AN/URR-13A receiver $88; APR-4 receiver AM/FM 38 to 2200 mc $165; HP/130B $288; GR/1551A $149; TS239A scope $49.50; FOB Hathorne. P. E. Boniface, P.O. Box 44, Hathorne, Mass.

HAMFEST-STERLING (Northwestern) Illinois, March 13, 1966, Sterling Coliseum. Advance registration $1. Sterling-Rock Falls Amateur Radio Society, P.O. Box 11, Sterling, Ill.

COLUMBUS (GEORGIA) HAMFEST on March 27 at the Fine Arts Building at the Fairgrounds. W4FIZ, 3804 Conrad Drive, Columbus, Ga. 31904.

VIKING 6N2 transmitter, Viking 6N2 VFO, Ameco converter CN-144, VHF preamp PV-50, power supply PS-1W, Heath Twoer, Heath Hybrid Phone Patch, David Decobert, 609 Henrietta Street, Gillespie, Illinois.

SB-110 with AC-DC supplies. Has not been checked on the air, $400. HW-10, $150. Will ship PP or deliver within 100 miles of Jacksonville, Fla. Ens. John Butrovich III, USS F. D. Roosevelt CVA-42, FPO New York, N.Y.

CB-253/ALR 30-1000 mc converter with RDO receiver, and model 14 keyboard typing reperforator. Want to trade on 75A4 or 51J class receiver. WØDNW, W. O. Wesslund, 2801 Wright Ave., North Platte, Nebraska.

HALLICRAFTER SR-150 transceiver like new for $385. Topaz 800 volt 250 watt mobile 12 v power supply, $75. Hy-Gain 20 meter 3 element beam, $30. W. H. Paxton K6ZHO, 720 Glenandale T., Glendale, Calif. 243-5979.

CERAMIC DISC CAPACITORS: .01 @ 600 v only 5¢ each. KKI2617, Box 6111, Baltimore, Md. 21231. Minimum order $1 plus 15¢ postage and handling. Stamps accepted.

SWAN 240 $200. Swan 117AC supply $75. Gimbel bracket included. Excellent condition. Will arrange sked. Lloyd D. McKillips K1ZTB, 317 Hickam Drive, Loring AFB, Maine.

WANTED TR-¾, NCX-5, S-Line. Condition unimportant. Cash and/or trade for Collins 310B-3, 51J2. State terms, condition, serial. R. Klein W3WXC, 7 Louella Drive, Norristown, Pa. 19401.

ELMAC STATION 80 through 6 meters. AF-68 transmitter, PMR-8 receiver, AC/DC supply. Excellent condition. $250. W. K. Gillen W2LBC/1, 845 Boylston Street, Boston, Mass. 02116.

HALLICRAFTERS HT-40 transmitter and Finco A-62 6 and 2 meter beam. Goes to highest offer. Ham, Rothbury Road, Wilmington, Delaware 19803.

MICHIGAN HAMS: Don't miss the Michigan State Convention in Saginaw on March 18 and 19 at the Bancroft Hotel. Details from W8CAM or WA8GRI.

FT-243 CRYSTALS: .01% setting $2.00 each, ±2 kc setting $1.00 each. 3000-8700 ks. Denver Crystals, 776 South Corona, Denver, Colorado 80209.

QSL CARDS?? "Made-to-order." Samples 25¢, deluxe 35¢, (refunded). Sakkers, W8DED Print, Box 218, Holland, Michigan.

TOOOOBES: 6146B $4.00, 6360 $3.45, 6CW4 $1.40, 8058 $8.55, 6146 $2.55, 417A $3.95. BRAND NEW. No pulls, seconds or JAN. Catalog free. Vanbar Distributors, Box 444X, Stirling, N.J. 07980.

MOTOROLA new miniature seven tube 455 kc *if* amplifier discriminator with circuit diagram. Complete at $2.50 each plus postage 50¢ each unit. R and R Electronics, 1953 South Yellowsprings, Springfield, Ohio.

POCKET STAMP (up to four lines) or 1000 labels (six lines) with call. 75¢ postpaid! Wholesale catalog (5¢ please). Brownville Sales Co., Stanley, Wisc. 54768.

HQE180C $250, Viking Valiant F/W $200, NC 303 $250, 6N2 matching VFO $95, Gonset G50 $200, all equipment with manuals and in good condition. William E. Daupert, Route One, Lebanon, Indiana 46052.

HQ170C with speaker $165. Art Linehan K-ZCP, 124 A Street, Manchester, N.H. 622-1602.

OUTHERN NEW ENGLAND HAMS: Auction of the year, March 8, 1966. Cronslaw Post, 40 Jones Street, Cumberland, R.I. Write for details to K1PNI, 133 Larchmont Rd., Warwick, R.I.

HEATH SB300 RECEIVER, six meter converter, speak-r, excellent, $275. Utica 650A transceiver, VFO, like ew $170. WA1BTE Paul LeTourneau, I LeTourneau St., Rochester, N.H.

HAMMARLUNG HQ170 with clock $267, Hallicrafters HT-37 $267. Only 1½ years old and excellent. Both for $499. Write or phone 644-2179, George Swiney KØSIM, RFD 1, Bennett, Colorado 80102.

AMPLIDYNE 621 TRANSMITTER. Never used $195.00. 30 tube square wave generator $30.00. VHF transmitter strip $2.00. Jerry Hirsch, WA2ZFA 215 California Dr., Buffalo, N.Y. 14221

DYNAMOTORS: 12v input 1000v 350 ma output $24.95. 12v input 1000v 250 ma and 500v 200 ma $27.95. Generator: requires gas engine drive, 1000 v 400 ma output $46.95. WA2OVR, 13 Kent Street, Trenton, N.J. 08611

I WOULD LIKE to trade my excellent Utica 650 six meter transceiver and VFO for an excellent two meter rig. Terrance M. Neal, 1127 Salvador St., Costa Mesa, California WB6HWL.

YUBA-DALMOTOR KW liquid cooled mobile linear $100. 32V-3, $175. KWS-1, 75A-4, 2.1, 3.1, 6 kc filters, speaker, $1000. KWM-1, all accessories, $400. James Craig W5VRO/1, 172 White Birch Drive, Pease AFB, N.H.

LIKE NEW SBE-33, mobile supply, amount, $290; excellent Valiant, $175; Hy Gain 14AVS and roof mount, $18.50; four 6146's, $12, Albert Johnson K1IIK, Newport, N.H. 03773.

W2AU CUBICAL QUAD 2 element for 10-15-20 meters. Never used. Complete instructions $40. Pick up deal only—Sorry. J. J. Doran, 178-09 132 Avenue, Jamaica, N.Y. Telephone LA 87269.

GLOBE CHAMP 300: 160-10 meters. 275 watts fone, 350 c.w., 500 p.e.p. with adapter. $150 or offer. WA8MZK Hilton Muntz, 417 Norway, Norway, Mich.

SPECIAL FILAMENT XMFR. 120v. 60 cy pri., 2 secondaries 7.6v @ 21 amp and 5.1v @ 13 amp. New. Sealed. $4.50 plus postage. Wt. 14 lb. A.R.C. Sales, P.O. Box 12. Worthington, Ohio.

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CERTIFICATE will be issued by Henry Ford Museum to any station that works the Motor City Radio Club station, W8MRM, during the 24 hour prior to the Old Timers Night banquet. Work W8MRM on May 7 (GMT) on or near 1.815, 3.663 (even hours), 3.900, 7.070 (odd hours), 7.215, 14.300, 50.178 or 146.94 Mc. Novice contacts by schedule. QSL for certificate.

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HAMMARLUND HQ-145-X, in very good condition, with 24 hour clock timer. Only $175. Contact Derrick W. Vogt, 130 Venice East Blvd., Venice, Florida 33595.

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WANTED British EL37 DX transmitter in fair condition. Box 590, Savannah, Georgia 31402

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INDEX TO ADVERTISERS

Propagation Chart

March 1966

J. H. Nelson

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	7*	7	7	7	7	7	7	14	14	14	14
ARGENTINA	14	14	14	7	7	7	14	21	21	21	21*	21*
AUSTRALIA	14	14	7#	7#	7#	7	7	14#	14	14	21	21
CANAL ZONE	14	14	7*	7*	7	7	14	21	21	21	21	21
ENGLAND	7	7	7	7	7	7	14	14	14	14	14	14
HAWAII	14	14	7#	7	7	7	7	7#	14	21	21	21
INDIA	7	7	7#	7#	7#	7#	14	14	14	14	14	7#
JAPAN	14	7#	7#	7#	7#	7	7	7	7#	7#	14	14
MEXICO	14	7	7	7	7	7	7*	14	14	21	21	21
PHILIPPINES	14	7#	7#	7#	7#	7#	7#	14	14	14	7#	14
PUERTO RICO	14	7	7	7	7	7	14	14	14	21	14	14
SOUTH AFRICA	14	7*	7	7	7	14	14	21	21	21	21	14
U. S. S. R.	7	7	7	7	7	7#	14	14	14	14	7#	7
WEST COAST	14	14	7	7	7	7	7	14	14	14	21	21

CENTRAL UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	7	7	7	7	7	7	14	14	14	14
ARGENTINA	21	14	14	7	7	7	14	21	21	21	21*	21*
AUSTRALIA	21	14	14	7#	7#	7	7	14#	14	14	21	21
CANAL ZONE	21	14	7*	7*	7	7	14	21	21	21	21*	21*
ENGLAND	7	7	7	7	7	7#	14	14	14	14	14	7*
HAWAII	21	14	14	7#	7	7	7	7#	14	21	21	21
INDIA	7	7	7#	7#	7#	7#	7#	14	14	14	14	7#
JAPAN	14	14	7#	7#	7#	7	7	7	7	7#	14	14
MEXICO	14	7	7	7	7	7	7	14	14	14	14	14
PHILIPPINES	14	14	7#	7#	7#	7#	7#	7#	14	14	7#	14
PUERTO RICO	14	14	7	7	7	7	14	14	21	21	21	14
SOUTH AFRICA	14	7*	7	7#	7#	7#	14	14	21	21	21	14
U. S. S. R.	7	7	7	7	7	7#	7#	14	14	14	7#	7#

WESTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	14	7	7	7	7	7	14	14	14	14
ARGENTINA	21	21	14	14	7	7	7	14	21	21	21*	21*
AUSTRALIA	21*	21*	21	14	14	7	7	7	14	14	21	21
CANAL ZONE	21	14	7*	7	7	7	7	14	21	21	21*	21*
ENGLAND	7#	7#	7	7	7	7	7#	7#	14	14	14	7#
HAWAII	21*	21	14	14	7	7	7	7	14	21	21	21*
INDIA	14	14	14	7#	7#	7#	7#	7#	14#	14	14	14
JAPAN	21	21	14	7#	7#	7	7	7	7	7#	14	21
MEXICO	14	14	7	7	7	7	7	14	14	14	14	14
PHILIPPINES	21	21	14	14	7#	7#	7	7	14	14	7#	14
PUERTO RICO	14	14	7	7	7	7	7	14	21	21	21	21
SOUTH AFRICA	14	14	7#	7#	7#	7#	7#	14	14	14	21	21
U. S. S. R.	7#	7	7	7	7	7#	7#	7#	14	14	7#	7#
EAST COAST	14	14	7	7	7	7	7	14	14	14	21	21

Very difficult circuit this hour.
* Next higher frequency may be useful this hour.

Good: 6, 7, 11-13, 15-19, 23-25, 27-30

Fair: 5, 8, 10, 14, 20, 26, 31

Poor: 1-4, 9, 21-22

VHF DX: 7, 12, 21, 22, 31

ENTERTAINMENT FOR HAMS

APRIL 1966 · 50 CENTS

73

73 Magazine

Wayne Green W2NSD/1
Publisher

Paul Franson WA1CCH
Editor

April 1966

Vol. XXXVII, No. 1

Cover by Wayne Pierce K3SUK.

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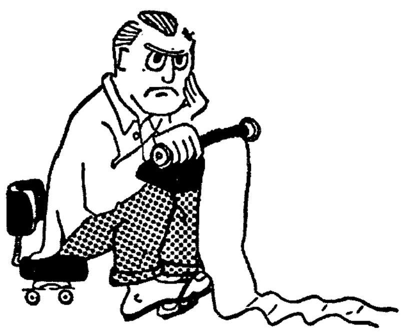
73 Magazine is published monthly by 73, Inc., Peterborough, N. H. 03458. The phone is 603-924-3873. Subscription rates $4.00 per year, $7.00 two years, $10 three years world wide. Second class postage is paid at Peterborough, New Hampshire and at additional mailing offices. Printed in Bristol, Conn., U.S.A. Postmasters, please send form 3579 to 73 Magazine, Peterborough, New Hampshire.



de W2NSD/1

never say die

100 Country Certificate

As announced last month 73 will make available a certificate for working 100 countries. Briefly, here is the dope. All contacts must be made after 1 May 1966 (0001 GMT). Certificates will be available for phone, CW and RTTY for each individual band for 100, 200, 300 and 350 countries. Countries will be those accepted by ARRL, RSGB, REF, DARC and other national amateur radio societies that we announce. We will have a complete list available for you about June first. Contacts made in any one calendar year count for the entire year and for the next four calendar years. 1966 contacts will be valid only through 1970. Cards may be sent to 73 with SASE for certification. We will try to establish local certification committees in various parts of the states and in other countries to simplify this problem. Each certificate application must be accompanied by one dollar or seven IRCs.

If you have any questions or ideas about this write to: GUS, 73, Peterborough, N. H. You can look for Ole Gus on 7025, 7245, 14065 and 14275. Gus can be reached by phone at 803-534-6485; collect calls will be refused.

May first is a Sunday . . . it should be an interesting day on the DX bands. You might spread the word ahead of time to make sure that as many of the DX stations are on that day as possible. It may sound something like a contest. You know that we will make a particular fuss over the first certificate in each call area and each country.

DX comments

Please don't feel annoyed if I make every effort not to get myself or 73 into the unenviable position ARRL is in with regards to their classifications on countries. They face insoluable problems in running DXCC.

For instance there is the little business of deciding what is and what is not a country. Any of you who have been following this situation know how ridiculous it has become. If you haven't been following it, trust me that it is ridiculous.

Then there is the interesting phenomenon of the DXpeditions which aren't really there. This may be an old time honored arrangement, but apparently it was considerably popularized by a gentleman (?) a couple years back who sat in air conditioned splendor in north Africa and signed a number of calls, all of which the ARRL has solemnly counted for DXCC. The feeling seems to be among one or two DXpeditioners that as long as ARRL is going to count it as if they were in a country and there is no one to stop them from signing the call from somewhere else, why go to all the bother of going to that country. Indeed, their logic seems quite valid.

We have also been treated to a new development . . . the DXpedition that can't seem to hear the top DXers calling them. I don't know how many of the top men were affected by this, but in a recent call Charlie, W1FH, explained that this finally broke him of the DX habit and he is off the treadmill.

Most of us have been aware of the ARRL's strong bias against phone operation, but I doubt if any of us thought that they would go so far as to completely cancel the phone DXCC award. This certainly is a major setback for the SSB gang.

(continued on page 114)

73 AFTER HOURS

April

April first is a traditional time for practical jokes and mischievous shenanigans. The urge to have fun is so great that even the editors of normally staid electronics magazines sometimes succumb to the desire to spice their usual technical and serious articles with a small touch of whimsy.

In line with this tradition, three years ago the April issue of 73 parodied QST. The cover of that issue was immediately recognizable as the style used by pre-war QST's and many older hams did quite a double-take when they saw *that* 73 on the newsstand or when it arrived at their house. Inside the magazine were a number of small touches of satire, too; the issue was tremendously popular with our readers.

However, the last two April 73's have been straight—at least as straight as 73 ever is. A few hams noticed this and suggested ideas for April. A number thought we should do a take-off on CQ. Well, to be perfectly honest, there isn't that much distinctive about CQ. The cover, with its (always) red logo could easily be parodied and it wouldn't be hard for a fertile mind to have some fun with the column headings and the columns themselves. But basically, we were afraid that a parody of CQ might have the same effect on hams that CQ itself does, and I'm sure that you'll agree that that isn't something we'd want to happen to readers of 73.

So nothing happened. Well, almost nothing. Someone always came up with an idea, but always too late.

Then Barry came to work for us.

Barry had a very fertile imagination. In fact, Barry had about as fertile an imagination as anyone really needs. Barry isn't working here now—I hear he went back to school—but while he was here, he suggested that we do a parody of Playboy.

Playboy? Ridiculous. How—or why—should a ham magazine do an imitation of a tremendously successful college boy-rising young bachelor junior executive magazine? And even if anyone had seen any virtue in his suggestion privately, giving other people credit for good ideas is not one of the big things here at 73, so we ridiculed him and went back to work. Then Barry left.

A few months later, I had a great idea. Why not do a parody of Playboy in April? It's so offbeat and far fetched that it could be a lot of fun. I suggested it to Wayne.

Ouch. After what he told me of my idea, I didn't speak to him for three weeks. Luckily, he was in Europe those weeks, so things weren't too strained.

When he came back, he told me that he had had the best idea while he was in Germany. Why not do a parody on Playboy in April? That was a satire that we could really have fun with.

I said, "Wayne, that's great!" And went out and bought a copy of Playboy (for research). Then I bought and analyzed some more copies (also for research) and discovered what it was that made Playboy so distinctive and popular.

Unfortunately, we couldn't use *them* in 73.

So I took another long look at the rest of the magazine and sent some ideas down to Wayne Pierce K3SUK, who does a lot of cartooning and art work for us. Well, Wayne invested in some research material, too, and you can see the results in this issue. We hope you like it.

Cover contest results

The winner of our cover contest was Bob Taylor with the uh, unusual, cover published last month. Bob makes those call letter sweatshirts that wow everyone at hamfests and club meetings. See December page 103 for more information on them.

(continued on page 118)

Ken Cole W7IDF
P.O. Box 3
Vashon, Wash. 98070

Barefoot and All That Jazz

A recent remark by a Six that he had run his Mohawk barefoot all winter brought no inquiry from the Bureau of Indian Affairs, and no atavistic response from the small percentage of my corpuscles entitled to take offense, but it left me wondering innocently why the Heath ethnology section honors the North American Indian so consistently and never suggests to the front office that a new transmitter be called the Frenchman, the Italian, the Yugoslav or the New Zealander. And, parenthetically, I do resent Benton Harbor's view that a Marauder is appropriate company for an Apache, a Cherokee and the rest. That's taking sides, Paleface.

Another firm, World Radio Laboratories, avoided specific tribal reference, and indeed may or may not have had redskins in mind when they decided Chief and Scout were names with customer appeal. But if these are simply brave labels and not subtly coercive allusions to frontier prowess, why not use Miner, Policeman or Nurse's Aid?

With these and other questions in mind I turned to the catalogs and soon decided that there's more to the naming game than meets the eye. Sometimes a change in nomenclature excites more interest than the thematic choices. Obviously in the Johnson Company (Thunderbolt, Viking, Challenger, Valiant, Adventurer) a major reappraisal was involved in retrenching to mere Courier and Messenger. I wonder what happened that day in Waseca, Minnesota? Nothing very decisive, apparently. Divisive, rather, for the Valiant Challenger clique seems to be sticking by its guns. Meanwhile, unimpressed by the arcing out front, sanguine craftsmen in the rear of the Johnson shop turn out handsome and expensive components for cold-blooded professional broadcasters who are responsive only to specifications. These artifacts bear no melodramatic names, but then no commercial multi-kilowatt transmitter is called Blockbuster, or Behemoth. Performance speaks louder than blurbs, but somebody isn't listening.

Hallicrafter seems to have had deeper doubts about labels with high muzzle velocity. Their Super Skyrider—Defiant—Challenger period was followed by a gentle turn toward cryptic letter and number combinations, however a company that starts with Sky Buddy and comes up roughly three decades later with Tornado! and Legionnaire! obviously thinks of itself as a swinger. So there is still a reasonable possibility that one day Hallicrafter will break out of its cryptogram phase with names pitched to shatter a brandy snifter at ten meters. But I trust not.

Sometimes, for one reason or another, it is impossible to detect a trend, and this would seem to be true in the case of Clegg. Their Interceptor is really not a name to conjure with, and Venus—an alias of Aphrodite—is a curious, mildly distracting choice. Come to think of it, why did they favor Venus? Why Roman rather than Greek? Rumors that an office party was responsible, like other involv-

ing deference to Geloso, owe more to frivolity than logic. Here is a puzzle. My own guess is that a subtle-minded executive topped off a perfect day with a double Martini (French vermouth, Dutch gin, Spanish olive, Italian name) and an amusing little memo scratching Aphrodite. And substituting Venus. Reluctantly I'll give him good marks for acumen, if not for chivalry, for it sounds quite odd enough to report, "I'm running a Venus barefoot." The Aphrodite theory may be deprecated by the company, but then I would point out that another Clegg product is called Zeus and the implication is that Venus wasn't arrived at by chance since simple consistency would have kept Clegg on Olympus, and very likely did until word came down from even higher that A. was out and V. was in. Too bad.

Turning without real regret from titular fantasies rooted in the ethnic, mythological and passably valorous, we find that a quality of menace is deemed attractive by some executives. Or, to be more candid, they have opted for the silly in preference to the ridiculous. Black Widow and Bandit are names that tie for a special award plus oblivion. And unless it was conceived as an incongruous tribute to a lovely airplane Spitfire takes second place. For coming up with Sidewinder Gonset wins a prize too, and if they decline on the shaky ground that this term is a slang reference to SSB then a palm will be added for mendacity. Sidewinder refers to a reptile. See the College Edition of Webster's New World Dictionary of the American Language. A secondary, colloquial meaning is also given and I am happy to quote it here: "A powerful swinging blow of the fist, delivered from the side." Aggrieved AM enthusiasts may see in this second definition a subtle technical validity.

Antenna namers fire shotguns from the hip and there is no coherency to the results. Hornet, Hustler, El Toro, Mark Something, Super Magnum (Antenna Specialists cum Smith and Wesson). Not until we come across Joystick and TrikStik do the hackles rise. These two unfortunate appellations are either offensively frivolous or Hugh Hefnerian. If the former then they don't deserve consideration, and if the latter a detailed analysis would be inappropriate in a family magazine. I'm referring to 73.

Well then, if clear-cut trends are difficult to visualize in the nomenclature favored by individual manufacturers certainly an inescapable message appears when one stands off a bit and surveys the industry. Take a deep breath and run the names trippingly off the tongue. Apache! Comanche! Thunderbolt! Thor! Viking! Tornado! (Move back.) Bandit! Warrior! Spitfire! Sidewinder! Black Widow! Challenger! Valiant! Mohawk! The message has Super Magnum impact, but I'm almost too nervous to read it. The mind reels before the panoply of menace and power, but do these sound like the names of refined electronic aids to friendly communication? Certainly not. A child would recognize them as automobiles. The Thunderbird yearns for a Thunderbolt; the Apache fits the Fury; put your Bandit in a Barracuda. Warrior and Mustang. Tornado and Tempest. Spitfire and Wildcat. Stuffy Marks this-and-that (issue of Britannia and King Arthur) can be accommodated by pseudo-Continental Monzas, Monacos and Rivieras. Inevitably a Galaxy (Space is In) presides in a Ford Galaxie.

Thanks to weak stomachs, or for some better reason, a few companies with familiar names have shown little inclination to go the frenetic route. National (*vale* SW-3 of hallowed memory) is one of these. Hammarlund is another, and indeed a short but impressive list of firms could be introduced as evidence that the emphatic banality of noisy labels is less than essential to the marketing of an inventory of quality.

In support of these holdouts one sees indications of relatively unadorned candor returning to our marketplace, of advertisements emphasizing specifications and price, and short on irrelevant fireworks. Granted this improvement is neither ubiquitous nor accelerating Thunderboltwise, yet how many of the latest of our sophisticated and eminently salable transceivers have names calculated to chill the blood? I can't think of any. Even hardnose linears are being given labels you can mention without reminding the kids of a TV program. Does this mean that the intrinsic discipline and rewarding efficiency of SSB have brought with them a bonus of maturity? Are our catalogs going to lose their links with comic books, TV and Detroit? I hope so.

Aggressiveness springs from insecurity, and the passage of time brings to most human endeavors a reasoned mellowing, a climate kind to merit. Defiant names fit weapons, not tools. Fifty years ago Fokker aircraft earned respect in aerial warfare; today in our country and in many others a Fokker design has won a tough competitive battle for success as a domestic route airliner. It doesn't have a horrendous name; it's called the Friendship.

Low cost, high power, single pole switching for our most popular VHF bands. It's good down to eighty meters, too.

A Simple Six and Two Amplifier

Bill Hoisington K1CLL
Peterborough, N.H.

Having been called on recently to build a commercial high power amplifier switching from 20 to 150 mc with complete frequency coverage for use as a laser modulator, I was very tempted to give it a whirl on the air as it was being tested through 50 and 144 mc. The customer was in a rush, though, so it was delivered, and another was built strictly for six and two, although it can be made to work down to 80 meters with a more expensive switch and more coils. The VHF model is probably of most interest, so I'll concentrate on it.

Circuit

There are three things that loom up large dollar-wise in this six and two meter amplifier: the tube socket, the blower and the tube. However, if you have a 4CX250 or two lying around and are thinking of the possibilities of a quarter kilowatt on six and two, this design allows you to switch bands with only one pole and one throw. You could also use a surplus, inexpensive, 4X150 in this circuit.

The circuit in **Fig. 1** has been used successfully up to 200 mc here. It is very hot on two meters and even more so on six. It can be seen to be a trough line pi network on two meters, changing to a good old coil type pi network on six. The switch is a slightly reworked (solder on some strap copper leads) knife blade copper switch with a porcelain base and it sure does the job. Used to sell for 50¢ in all the hardware stores. Maybe still does.

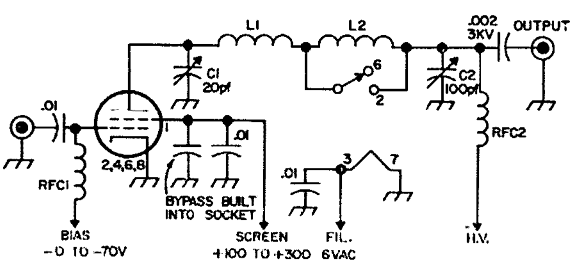


Fig. 1. Schematic of the 4CX250 amplifier for six and two meters using single pole switching.

Note in the circuit that the RF plate choke is at the low (for RF) end of the plate inductor, LI. This particular choke has a slight absorption spot near 70 mc which does not bother in any way on six and two meters, but can be a nuisance when working for complete coverage from 20 to 150 mc. On the job mentioned I switched chokes from the front panel to jump over 70 mc.

RF output circuit

I would advise getting a good socket with the screen bypass built in. This capacitor is in a circular form around the tube, and believe me, there is nothing like a round flat disc for VHF and UHF capacitors. During several weeks just spent on this unit running up and down between 18 and 170 mc many times with all kinds of coils, switches and capacitors, not once did it self oscillate. And this is with no neutralizing at all. The built in screen bypass is really doing its job of isolating the input from the output circuit. It also has another job to do as you will see.

A word about RF currents in screen-grid coaxial tubes is in order here. Electrons, as is well known, flow happily from the cathode of these tubes over to the plate, greatly attracted and speeded up on their way by the high positive plate voltage. Field theory says that an electron finding itself in a vacuum between two conductors, one positive and the other negative, will accelerate and slam into the

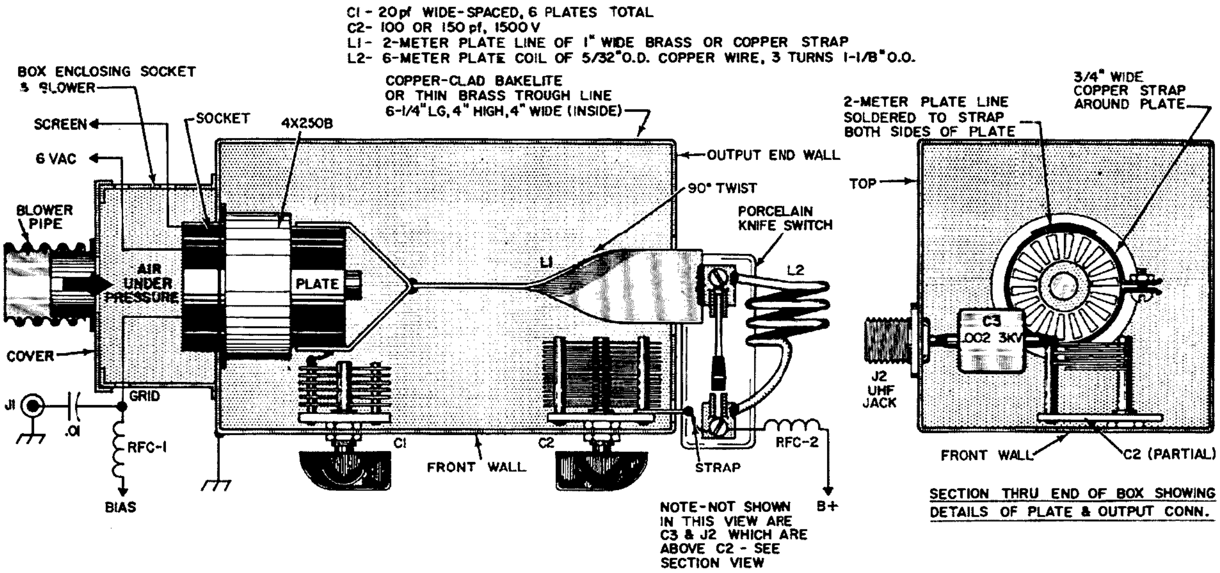


Fig. 2. Top and side views of the 4CX250 amplifier.

positive conductor at a remarkable number of miles per hour, if the voltage is high. In fact they will get well up towards the speed of light with many thousands of volts.

However, they do *not* travel at the speed of light in tubes in amateur use, and thus are subject to the much talked about transit time effect. The point here is that in order to know what is going on RF-wise in VHF and even more so in UHF, you should differentiate between the electron flow and the RF current flow. A positive *wave* from the RF drive on the grid causes electrons to go through the grid. With a few landing on it of course. At the moment they go through the grid they see the screen ahead of them with all that beautiful 250 volts positive on it and away they go like dogs after the electric rabbit. Same thing happens all over again as they go through the screen, only this time they see 1500 volts (minus the 250 of the screen) and really get moving. (This is where the blower comes in, by the way). Arriving at the plate these electrons, being little particles of negative electricity, cause the plate to go negative. Now, watch out. The wave-front created on the plate travels along the plate line LI at almost exactly the speed of light, reaches the cold end of the trough line about a quarter cycle later and then starts back again, reaching the opposing conductor that is, the conductor in the tube that is RF-wise attached to the walls of the trough line, as is right and proper. But what is this opposing conductor? Is it the cathode? Nope. The grid? Guess again. It is none other than the highly by-passed screen. The RF waves in the trough line cannot get through the screen. The screen is thus the second most important element for the RF output, not the cathode.

The cathode leads need to be short for the input circuit however. So, the moral is, pay attention to the plate-screen RF circuit here for those hundreds of watts out you are looking for.

High power VHF trough lines

Getting down at last to the actual construction ("tin cutting") we see in Fig. 2 a top view of the trough line, switch and 6 meter coil. The socket is mounted in the center of the front end which is 4 inches by 4 inches thin brass .022 to .025. A flat box is also mounted under the socket with a cover containing the blower pipe hole. This cover is fastened with four screws, which allows work on the socket later if needed. A well insulated and spaced low capacitance grid lead is brought out to RFC 1 and the grid input capacity. This must be air sealed of course, as well as all others going through the socket box, in order that the air from the blower will be forced *through* the socket, which is designed for that purpose. The air continues on through the plate fins after going through the socket.

The tuning capacitor C1 should be able to take care of the B plus voltage of some 1500 volts, or higher if you're that anxious. The RF voltage may be considerably higher than 1500 if the plate circuit is operated unloaded. (Not advisable for any length of time!) Do not make the usual pencil test unloaded without having that pencil on a stick! Insulated! The RF really rips out but plenty. Not just a little

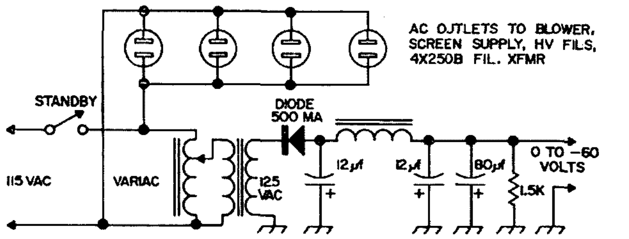


Fig. 3. Bias supply for the amplifier.

spark but a *roaring arc.* Don't say I didn't warn you.

The actual plate connection is a thin copper strap (soft copper) with its ends bolted together. The plate line, composed of two 1 inch straps at the plate which are joined together about 2 inches from the plate making a single strap from then on, is soldered to the plate strap in two places as can be seen in **Fig. 2.**

Fig. 2 also shows the positioning of the output capacitor C3 and output jack J2. C2 and C3 are actually *inside* the front trough line wall. The knife switch is mounted on a wood block about 1¼ inches which brings it up to level of the plate tank line (2 meters) which is positioned in the middle of the 4 inch high trough line. The flat handle of the knife switch may be extended through a front panel. Insulated! A panel is advised, as the switch, L2, C2, and one end of C3 are all at high voltage. I used bakelite shaft extenders and mounted the front panel, 3/16 inch white plastic, about one inch in front of the front wall of the trough line. RFC2 is 80 turns of No. 20 solid, covered wire, 2¼ inches long, wound on a ceramic form ½ inch O.D.

That about does it except for a few details. The output end wall and the socket wall are of thin brass, .022, some 4 by 4 inches square. The RF output jack is mounted on a strap which is soldered across the top of the trough line. You can also close the top in with a brass cover if you wish, and the efficiency will go up a percent or so on 2 meters. I have not done this yet. The output end wall has a large hole cut out in the middle (not shown) for the cold end of the 2 meter plate line to be led outside to the switch. Note that when using a pi network this is only cold to the extent of being near 50 ohms.

Again a word of caution. I tuned this rig up frequency-wise on low voltage, about 250 to 500 volts. I don't like to lose readers.

Driver and power supplies

So far I have only driven this amplifier with the "50 Watts For $50" rig to be described in 73 Magazine. The RF drive power, that is, grid input to the 4X250B, is listed as from 0 to 2 watts in the handbooks, so take your choice as to drivers. Even a Sixer should do it. I have used various powers on the driver and it seems to settle out around 10 to 12 watts DC power to the driver, with the untuned grid circuit, cable, and driver being used here. The cable connecting the driver at the moment is about 5 feet long. With an untuned grid circuit this cable can change the RF voltage on the grid up or down a considerable amount as can readily be seen. At or near a quarter wave length and tuned by the grid-cathode input capacity of the 4X250B there could be a lot more RF on the grid than with a half wave on the line where one could expect something like the exciter link voltage to be found on the grid.

Exciter drive power and modulation of the driver should be adjusted while listening to your own voice or with a scope. You'll soon see why when you do it.

Bias supply

We had some trouble at first with a large jump in grid bias voltage under RF excitation and modulation. This was due to the bias source not being "stiff" enough, and was remedied by the bias supply shown in **Fig. 3.** Using this supply the negative voltage was 70 without RF drive, 80 with drive, and about 85 when modulating the driver. The Variac shown in the primary of the bias supply is of course a better method of regulating such a supply than a potentiometer network in the DC output.

Screen supply

Nothing fussy about the screen supply. Just 0 to 300 volts, 50 ma, adjusted by another Variac. The "Turn-On" switch has a 115 volt outlet which goes to the HV Variac, which is in the primary of the HV transformer. This allows the screen and HV to be turned on at the same time.

HV supply

Again nothing special. I'm using my old KW job, tapped down to 1500 volts AC maximum. And of course, another Variac! Caution! Do not operate the tube with the screen on the plate off! All those electrons which are supposed to go to the plate land on the screen and wowie, what screen current! Very bad for a $38 tube.

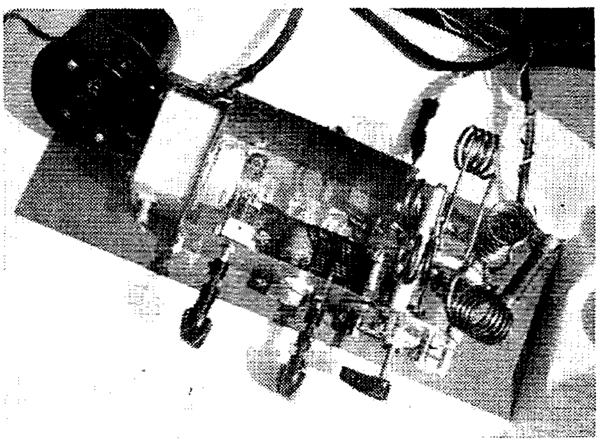
Results

First, be sure that there is at least 50 or so volts negative bias on the grid and that it can be varied. Set the screen for about 100 to 150 volts and the plate for say, 500 volts. This is without any RF drive. No plate current should show. Drop the bias down carefully. Plate current and screen current should begin to show. Adjust the plate current to about 100 ma for a start. Then apply drive on 6 meters using a dummy load, for example a 100 watt bulb in J2. Plate current should jump up to some 200 ma. A good plate dip should now show under resonance on rotating C1 with C2 at maximum. Adjust C2 for load, returning with C1. This pi network should adjust nicely from a large plate dip and little RF output with C2 at maximum, through a maximum RF out at the proper setting, and on to very flat or no tuning at all with C2 at minimum. This last is *not* the place to leave C2 and plate current will be heavy. A little practice will show you how to operate the pi net. The maximum RF output point is very noticeable over quite a narrow range at or near the proper setting for C2. On 2 meters of course there will be a great deal less of C2 for maximum output.

All Band Switching?

As mentioned in the introduction of this article, this circuit can be used in a real "all-band" amplifier—at least down to eighty meters. Perusal of many journals turned up several articles on the 4X150 series tubes, but most of these used on two meters called for large plumbing in the form of 1½" tubing which is not easy to work with. None of them, to my knowledge, used switching from two to six—or lower.

Being an ardent VHF-UHF contriver since the pre-WWII days on five meters, I have always been slightly annoyed by articles and rigs with the title "all-band" only to find the range to be eighty through ten. With this amplifier you can switch from two to eighty meters. You can also build it out of copper-clad bakelites and thin brass without going to plumbing. Fig. 4 shows the circuit when going down to 20 mc, which I have done, or all the way down to 80 meters, which I have not done yet. Note particularly the shorting of all coils not used, by the multiple arms of the switch, and the switching in of additional loading capacitors as the wavelength increases.



Here's the continuous coverage 20–150 mc laser modulator that led to the simpler six and two amplifier.

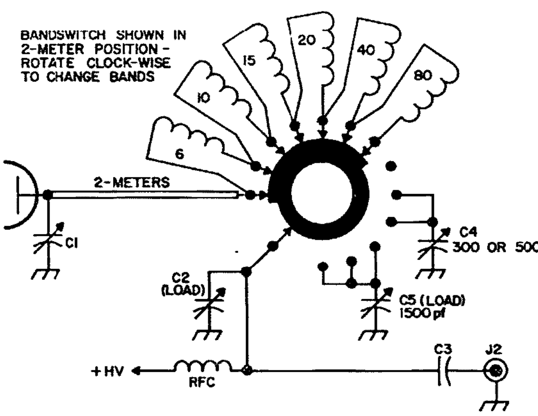


Fig. 4. "All band" version of the amplifier.

S1 is shown in the 2 meter position. The Radio Switch Corp. of Marlboro, N.J., makes excellent units of this type in a variety of sizes. Personally, I have always favored one complete operating position per band, but this rig may change that. A complete rig per band can get a little expensive, which is why I like Compactrons and the simplest type of rigs possible. I like to sit down at a table and have the 2 meter antenna connected to the 2 meter rig, the 2 meter converter, etc. Well, that is for you to decide, and this switching amplifier gives useful food for thought. If you get up beyond the 500 volt, 100 watt class, the modulators get cumbersome, so one big modulator could be switched. You have to suit yourself on this complex question.

Now check for good modulation using a tuned diode, transistor amplifier, and padded earphones as explained in previous articles. This little system allows you to hear yourself as others hear you!

There are several adjustments for an AM linear. The amount of RF drive is important; the fixed bias on the grid; the amount of driver modulation; the screen voltage; and the RF loading of the plate circuit. The effects of these are readily heard while listening on the "system". All handbooks on AM linears mention the adjustments as "critical". If you try to put one on the air without *listening to it yourself*, this could be true. But if you have the means to hear what is going out, then I do not agree. I have left the adjustments alone for weeks and still OK. Modulation reports, "Excellent," "modulation a little heavy but good," and so on. Don't forget that an AM linear is 66% efficient RF-wise under driver modulation. Not 33% as sometimes mentioned by handbooks. Some of them (handbooks) have only committed "sins of omission" by just mentioning the 33% and not saying anything about the 66%.

This article mainly concerns obtaining 6 and 2 meter RF with a low-cost simple switch. This it does! I have received various reports running from "an increase of 1 S unit," to "you went up 3 to 4 S units" comparing the linear with the 50 watt set. Also, I have by no means pushed it yet, running only about 200 ma and 1000 volts maximum so far. Will try high level modulation and more power later. After all, this bottle (ceramic it's true) is conservatively listed at 250 watts *output* in the tube handbooks, so, we'll see.

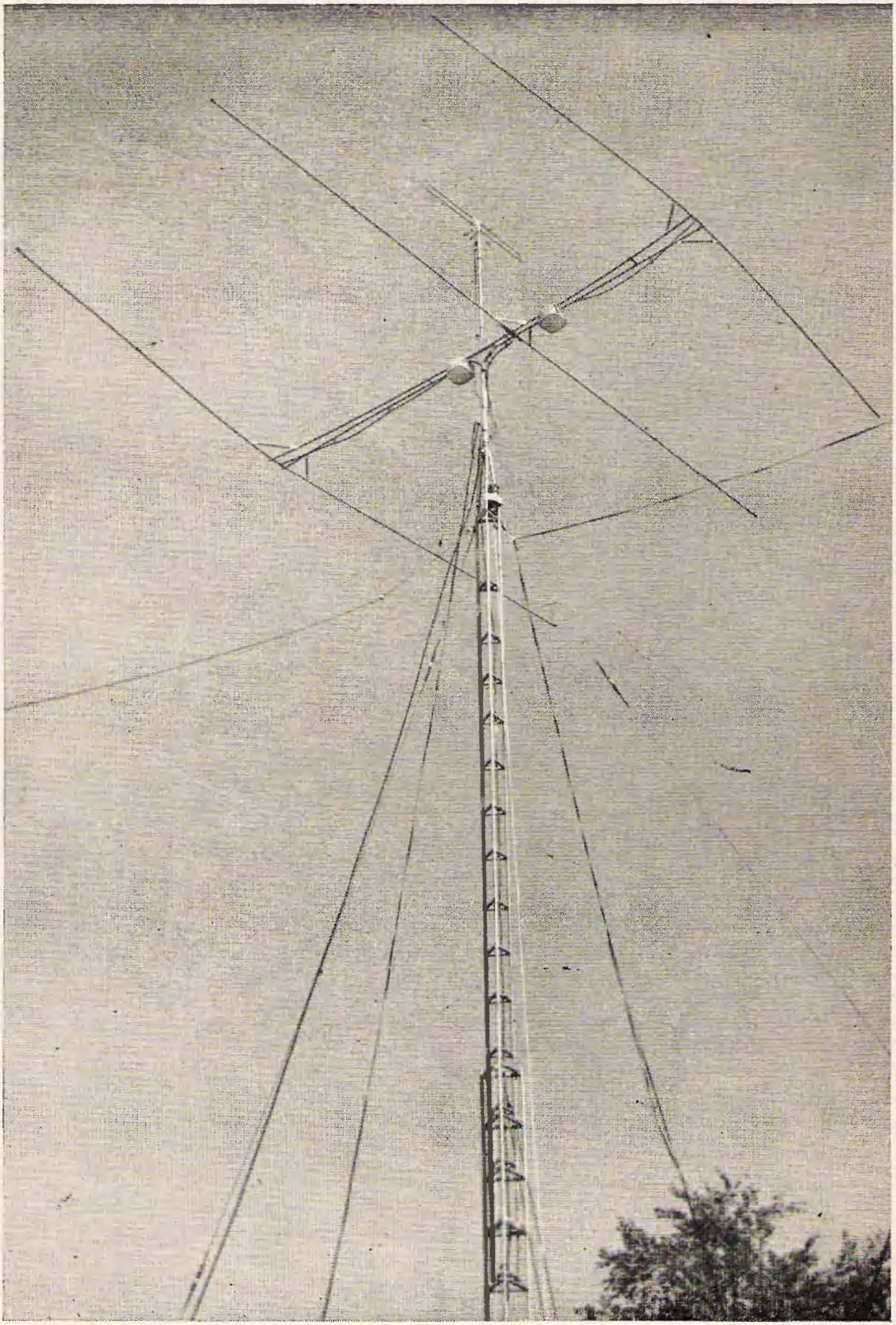
. . . K1CLL

*A scope is recommended. Editor.

That Pretty Anodizing

Many fellows who build gear for themselves are very happy when they get hold of some of the beautiful anodized aluminum that is available. It makes attractive construction projects, but they unfortunately often work very poorly. The culprit is that beautiful finish. Aluminum anodizing forms one of the finest insulators known. It is almost glass-hard and has excellent dielectric strength. So when you used anodized aluminum, scrape it thoroughly any place you expect electrical contact to exist. Don't rely on toothed lockwashers. Remove the finish by sanding until you see that ugly bare aluminum.

. . . Jack Bayha W8BPY



Hartland Smith W8VVD
467 Park Avenue
Birmingham, Michigan

The Bee Eliminator

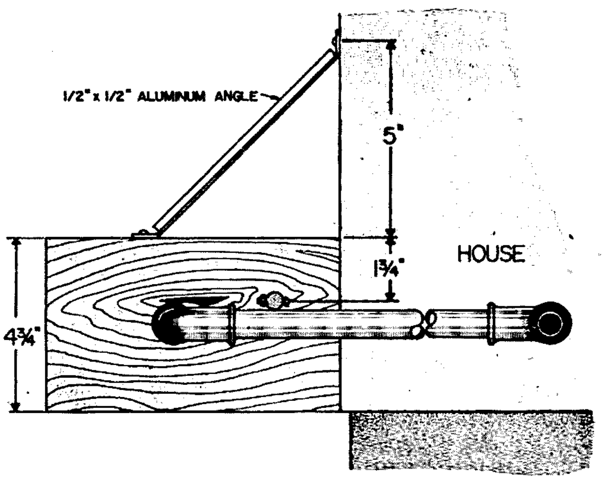


Fig. 2. Side view of winch.

Tired of having to promote antenna raising or lowering bees whenever you want to try a new beam or repair an ailing sky wire? The Bee Eliminator will free you forever from the need for borrowed muscles when it is tower wrestling time. Constructed of readily available material, this simple device offers the advantages of a tilt-over tower at a fraction of the tilt-over tower's cost.

The prototype illustrated in the accompanying photo and sketches consists of a U-shaped wooden support and several pieces of ½" galvanized pipe fashioned into the drum and crank of a hand operated winch. The dimensions shown are not critical and so they may be altered to suit your own requirements.

If you can't mount the winch at the corner of the house, as in the author's case, increase the length of the side boards from 8" to 20" to provide plenty of knuckle clearance for your cranking hand. A reduction in the crank's length is not recommended, since the shorter you make it, the harder you'll have to work when raising the tower.

A 14" steel rod acts as a safety stop to prevent the crank from running backwards when the winch is unattended. The stop should always be pushed to the right, except when you are actually turning the crank. Small bolts in the ends of the rod keep it from accidentally sliding out of the U-frame.

Provided there is no more than a 400 pound strain on the pulley attached to the tower, you can use the Bee Eliminator without modification. Greater loads, however, will require ⅜" nylon rope, heavy duty pulleys and added bracing of the winch box. Manila rope should be avoided because it lacks both the strength and excellent weathering properties of polyethylene and nylon. . . . W8VVD

W8VVD is a self-employed mail order dealer of 8 mm film and supplies. He's written many articles for all of the electronics magazines.

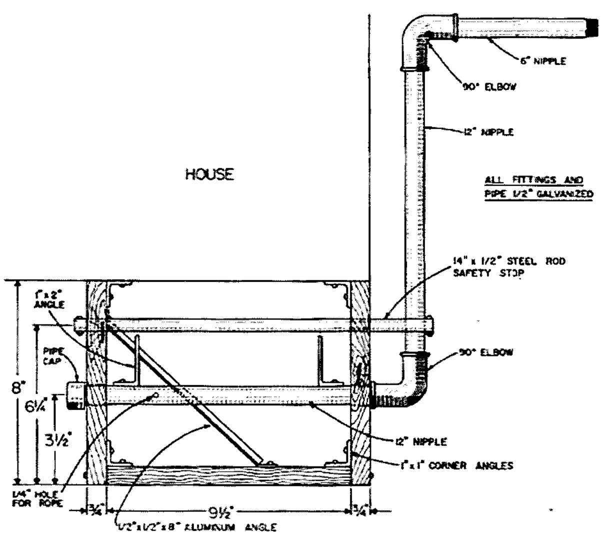


Fig. 1. Top view of winch.

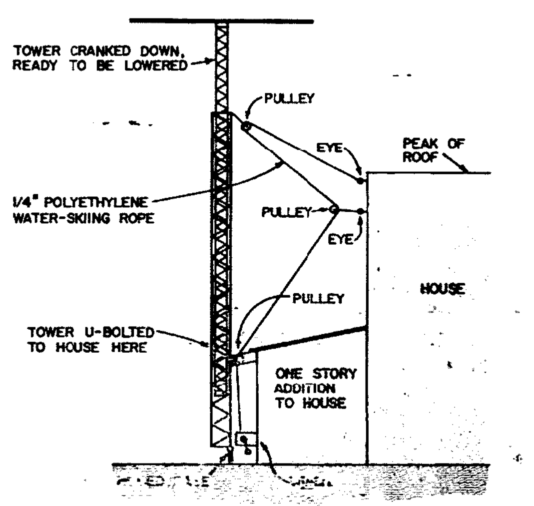


Fig. 3. Method of stringing rope between tower and winch.

Carmen Diodati K3PXT
93 N. Hilltop Drive
Churchville, Pa.
Photos by W3IKH

The Six Meter Jewel

A complete six meter VFO controlled fifty watt transmitter.

"Well, the rig here is home brew." A request for additional information reveals the following: Power supply, modulator, exciter and vfo are on separate chassis complete with interconnecting cables.

Since many hams do not have rack mounted equipment, the resulting conglomeration of cables and chassis is usually not scenic. The average ham, by nature a procrastinator, never quite gets around to removing the haywire appearance which is normally generated in his anxiety to get the new rig on the air.

If signal reports are satisfactory, appearance be darned! The rig works swell (the ultimate goal) so why worry. If anything goes wrong with the rig, we'll take care of it then.

Pictured here is a 6 meter gem designed and constructed by W3GMA and K3PXT. Two identical units have been constructed, the only variation between the two is a result of parts available.

As to function—K3PYB, harmonic of PXT, can attest to 7 states the first day of operation, and has since worked 23 confirmed states with very little effort. Signal reports were: You're 5-9 plus, lots of QRM on your frequency om, but you're pounding right through, absolutely no difficulty copying your station, beautiful clean crisp signal, etc. In general reports have been such that MYL is kept busy sewing on the shirt buttons.

The cost of this unit is negligible since most of the parts have been salvaged from discarded idiot boxes. Parts not available from passe boob tubes were purchased surplus.

Most important is the feeling of pride with the statement, "Well the rig here is homebrew," while surveying the neat compact rig that you have built and are operating.

K3PXT is an employee of the Frankford Arsenal, Metrology and Calibration Group. The Jewel is a club station (K3WBI) project for some of the club members.

Circuit description

The power supply uses a single transformer for both low and high voltage. The low voltage section uses two 6AX4's in a full wave rectifier circuit. Capacitor input insures minimum hum in the audio circuits. The high voltage circuit consists of a 5U4, combined with the rectifying elements of the 6AX4's as a bridge

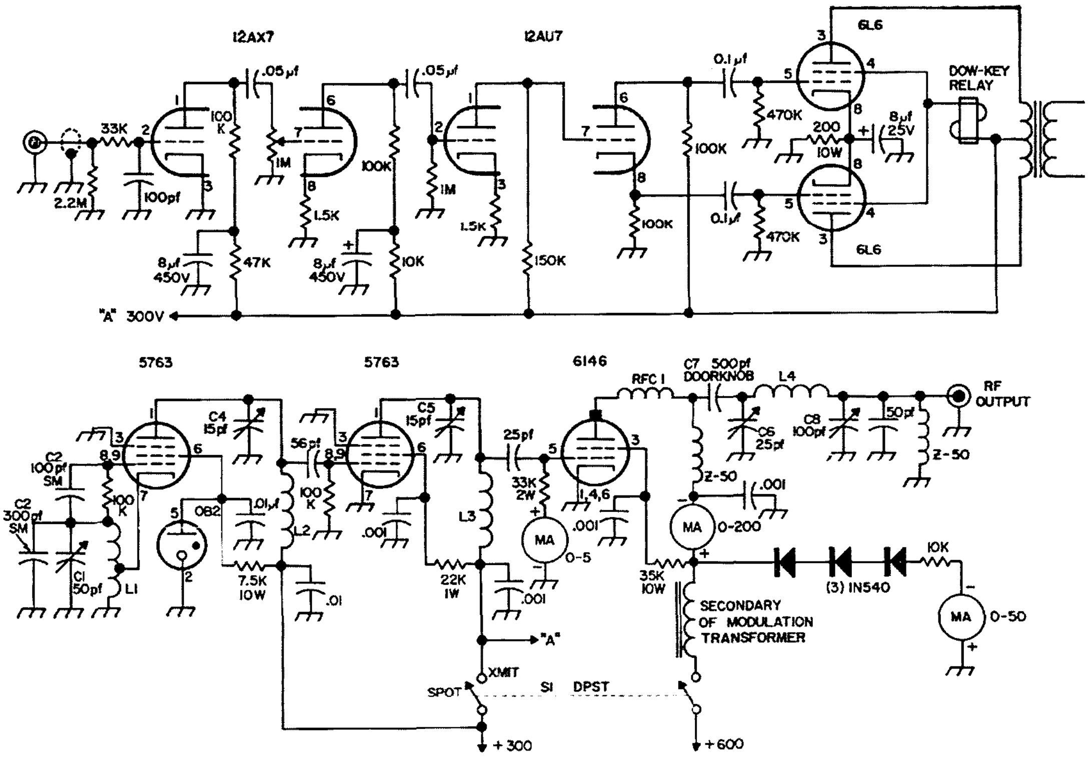


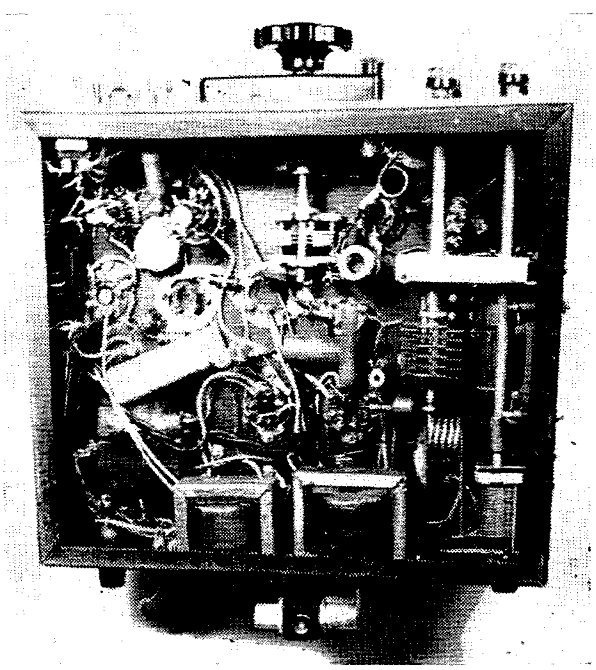
Fig. 1. The Six Meter Jewel rf section and modulator.

circuit. Choke input provides good regulation for the 6146. A dpst switch removes the dc voltages from the plates of all tubes for standby operation, while simultaneously deenergizing the Dow Key ant relay.

The rf section uses a 5763 as an electron coupled Hartley oscillator which tunes from 8.3 to 9 mc. The tuned circuit of the oscillator is loaded with a high C to L ratio for good stability. A voltage regulator supplies the screen grid (oscillator plate) which is electron coupled to the plate circuit. This electron coupling isolates the oscillator from the following stages. The combined high C to L ratio, voltage regulation and electron coupling results in a very stable vfo with effectively negligible frequency shift.

The plate circuit of this stage is a frequency tripler, capacitance coupled to the following doubler stage. The doubler is in turn capacitance coupled to the input of the final at the operating frequency, with a very healthy 4 to 5 ma of grid drive throughout the entire 6 meter band. The output of the final utilizes the very flexible pi-coupled network for greater harmonic attenuation, and relatively constant impedance throughout the entire band. An additional advantage to this method of coupling is that it may be used at some future date as the input to an amplifier for additional power, when deemed necessary.

The modulator section is straight forward. using three stages of RC amplification before a direct coupled hot cathode paraphase amplifier, which feeds a pair of old reliable 6L6's, operating class AB1, for plate modulation. The umbypassed cathodes of the amplifier combined with the direct coupled paraphase amplifier, results in excellent frequency response. Most important, however, is the elimination of an interstage transformer's space and cost.



Bottom view of the Six Meter Jewel.

Construction

The complete transmitter is constructed on a 12 x 10 x 3" chassis. The front panel is 12 x 8". Its sole purpose is to mount the meters. The meter at the left is the modulation indicator which at the time the pictures were taken was not wired in because of the author's inability to scrounge the necessary diodes at the time. This meter is used to ascertain that modulation does not exceed 100%, thus avoiding splatter and distortion. The center meter is the final amplifier plate current and the meter to the right is the final grid. Using the proper shunts, multipliers, and switch, one meter can be used to monitor these circuits. The individual meters provide simultaneous monitoring of the important circuits and an instant indication of any difficulties that may arise during transmissions.

The oscillator dial (lower center) is a National Velvet Vernier drive. This unit requires no mechanical change and is mounted directly to a Hammerlund MC 50S variable capacitor. The dial is marked 0 to 100. A calibration chart may be used for frequency identification, or the spot switch technique of zero beating the receiver can be used to determine frequency within the calibration accuracy of the receiver. The latter method, of course, is the most practical.

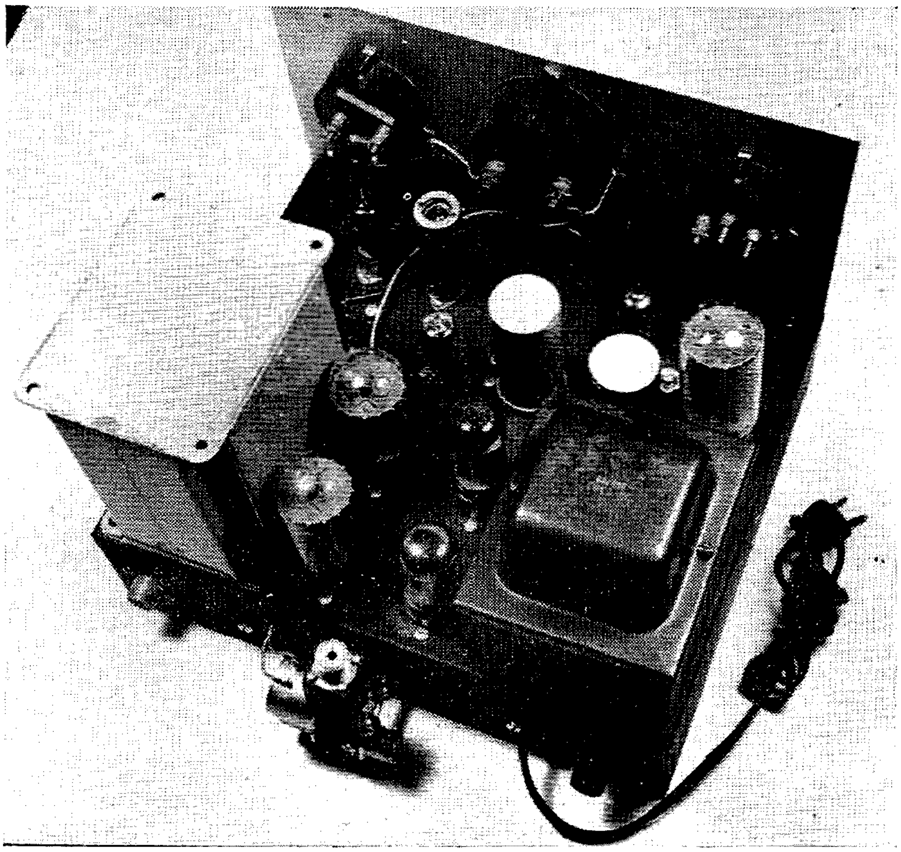
The 6146 final is mounted in a horizontal position beneath the chassis. Small holes spaced ½ inch apart on the top and side of chassis provide sufficient ventilation for cooling. This method of mounting the final makes efficient use of space that would normally be wasted.

In general, the layout is simple. There is no crowding of component parts, ample room for wiring and soldering, nor is the rig constructed elevator fashion (level on level) as can be seen from the photos; practically all component parts are easily accessible for trouble shooting when required.

Calibration and adjustment

The rf section is adjusted for proper frequency stage by stage with the aid of a grid dip meter. The over modulation indication meter is adjusted as follows: speaking normally into the microphone adjust the modulation control until the needle deflects sharply upwards at speech peaks. The upward swing of the meter now indicates that modulation is in excess of 100%. Now slowly turn back the modulation control to the point where meter movement no longer occurs at peaks.

The meter effectively eliminates the need for a scope for modulation adjustment and permits easy adjustment for obtaining 100% modulation with no fuss.



Top view of the Six Meter Jewel.

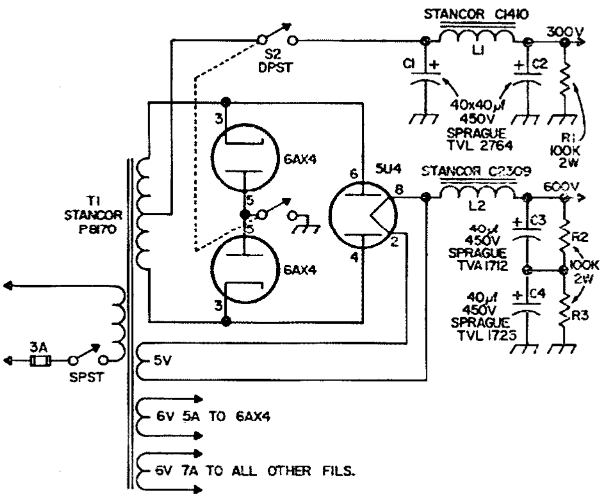


Fig. 2. Power section of the Six Meter Jewel.

The filaments should be set to on, at least a half hour before operation to ascertain minimum drift of the oscillator, however, the longer the filaments are on the more stable the oscillator. Set the Trans. Rec. switch to Trans. and adjust the tripler tuning and doubler tuning for maximum grid drive. Adjust the plate tuning for minimum plate current and the plate loading for maximum indication. Alternate between the two until a plate current of 120 ma is obtained.

When changing frequency, it is not necessary to retune the transmitter unless the grid current drops below 3 ma; it is only essential to redip the plate tuning and adjust the plate loading.

Conclusion

This rig as constructed is ideally suited for the ham who has a limited operating space, its size is such that it is easily transported from Qth to Qth during periods of mobility (vacations, etc.).

It is the writer's intention to construct transmitters of this type for several bands, each transmitter completely independent, yet capable of driving an amplifier for greater power when deemed necessary.

Most important a breakdown in one transmitter will not curtail operating activities for more than a single band. Meanwhile we'll look for you on 6 meters.

. . . K3PXT

Coil Table

L1. Oscillator, 9 turns number 20 on ¾" ceramic form. Tapped third turn from cold end.
L2. Tripler, Like L1, but no tap.
L3. Doubler, 5 turns #18, ½" diameter, ⅝" long.
L4. Plate, 5 turns #14, ¾" diameter, ⅝" long.
RFC1. 6 turns #22, ¼" diameter, spaced wire diameter.
RFC2, 3. Ohmite Z50.

A formula for optimum spaced—
optimum gain parasitic antennas

The Ascendency Curve Yagi

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When the Japanese physicist, Doctor Yagi, released his design formulae for the now famous antenna design which carries his name, a new era in directional, narrow band, relatively high gain antenna performance was born.

In the nearly three decades that have followed many an ardent antenna man has attempted to improve or refine the basic yagi formulae and some have met with varying degrees of success.

Most recently, although the period extends back more than ten years, the very long-many elemented version known variously as the Long John and long yagi has captured the spotlight in amateur antenna design circles.

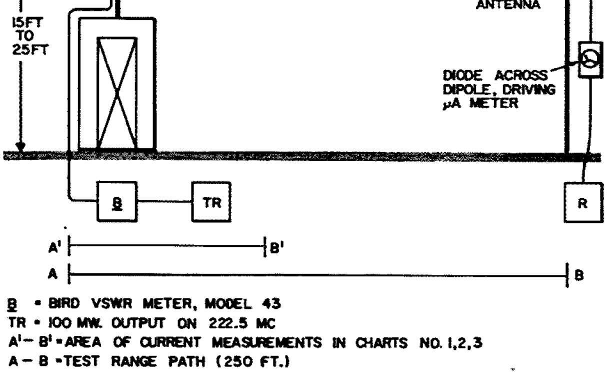


Fig. 1. Test set up for the antenna measurements described in the text.

This antenna design, sporting six or more parasitic elements, has developed along the theoretical lines of "if a little bit is good, a lot is better"; referring to the total number of in line elements in the antenna plane.

Unfortunately this is not always true. The mere presence of additional elements is no guarantee that performance of the antenna will improve. And in fact the converse has been found to be true if the designer is not extremely careful as to where he places his elements and how they inter-act with other elements in the same or similar planes.

Very briefly, the basis for any parasitic antenna is the driven element or dipole. With the addition of a *longer-than-driven element* element (the reflector) the radiation pattern of the dipole changes from bi-directional to uni-directional. And the characteristic feed impedance of the driven element changes; it lowers.

With the addition of the first *shorter-than-driven element* element (the director) the radiation pattern of the antenna changes still further, narrowing in the front (i.e. through the director element). And the characteristic feed impedance changes once again; still lower.

Beyond this point (the three element beam) the addition of parasitic elements usually takes place ahead of the first director. And with each additional director, the theory is that the forward horizontal and vertical radiation patterns sharpen resulting ultimately in a highly directional antenna that radiates essentially only in the forward direction over a compara-

tively narrow horizontal and vertical field.

However as additional directors are added to the antenna, each one has a corresponding "field effect" on those elements already present and many of these elements will in turn have an affect on the characteristic feed impedance of the driven element; lowering this impedance still further.

At some point in the addition of directors the feed impedance fluctuations stabilize and only the forward pattern (and to a small extent the side lobes) are further affected as additional elements are mounted.

Inter-element relationships

The primary consideration, then, in the careful design of any optimum gain parasitic antenna is the careful derivation of the final operating position of the various parasitic elements. Inter-element relationships is of primary concern.

A number of text books and published sources contain reference data for the design of optimum gain yagi antennas. If you will carefully analyze these standard sources you will quickly discover that no two are alike and many differ widely in approach.

Most however claim to have reasonably coinciding results.

Anyone who has worked with parasitic antennas is aware that two widely diverse sets of dimensions for two antennas, each to perform over the same frequency range, will deliver two widely diverse sets of performance parameters.

Our aim here is simple. To illustrate under carefully controlled laboratory conditions the inter-element relationships found in parasitic element antennas of up to eight elements, and to suggest that any VHF-UHF antenna enthusiast following the procedures outlined here will have as a finished product a yagi antenna that squeezes an extra 10 to 20 percent forward gain into the troposphere, with each parasitic element delivering *true optimum performance.*

Measured inter-element relationships

All design work, measurements and results were gathered under reasonably *pure* laboratory antenna test range conditions using the equipment set forth in **Fig. 1.** The results here have been duplicated over a wide range of frequencies covering 50 to 950 mc and comparative analysis has been performed using both commercial and so-called standard handbook design yagi antennas in the amateur 144 and 220 mc bands.

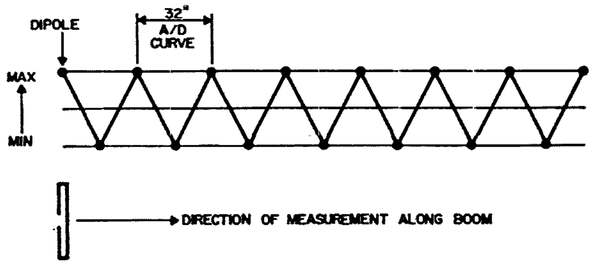


Fig. 2. The measured current peaks found in front of the driven element (dipole) of the test 222.5 mc yagi when the driven element was mounted by itself on the test boom. Note the 32 inch (0.6 wavelength) symmetrical current (power) peaks as the test receiving dipole and meter were moved away from the driven element.

In each instance the test results indicated an improvement in forward gain over conventional existing antennas or designs varying from a low of ten percent on the better designs to a high of 20% on those not so good.

Reference is first made to **Fig. 2.** This illustrates the principal of measured wave fronts or *current points* as found along the forward (right angle) path of fire from a gamma matched and resonant 222.5 mc driven element, suspended on the test range.

A floating reference pick up dipole feeding a micro-ammeter field strength indicator was moved along the horizontal radiation plane of the driven element and measurements made of the physical distance between corresponding current peaks. These distances are plotted on chart number one, and they correspond to 0.6 wavelength in free space at the operating test frequency of 222.5 mc. (*Note:* 0.6 wavelength is an observed phenomenon and should not be confused with 0.5 wavelength current peaks normally *assumed* in antenna theory discussions.)

In step number two a reflector element, 5% longer than the driven element at the test frequency, was mounted on the same boom with the driven element, and a down-test range field strength meter was observed while the reflector was positioned for optimum forward gain.

In step number three a 2.5% shorter-than-driven element director, was mounted on the same boom and the identical down range field strength indicator was utilized to position the director in the position on the boom where optimum forward gain could be measured.

In both steps, the addition of the reflector and the addition of the first director, the gamma-matched driven element was re-tuned for optimum loading and minimum VSWR as indicated on a Bird thru line meter with a

250 milliwatt element. In each case the VSWR was lower than 1.2 to 1 after adjustment.

Fig. 3 references the physical spacing of each element, with its neighbor or neighbors, starting with the addition of the reflector element.

Fig. 3 should be studied at this time. Here the reader will observe that as additional directors, beyond the first, are added, and the down range relative field strength of the antenna increases, various changes take place in the physical spacings of the already positioned elements and the gamma-match setting.

After the second director is added (i.e. the four element parasitic) the gamma setting becomes uniform indicating that in this particular design approach any five or more element beam (using three or more directors) will load with the same gamma (or other form of matching) setting as a four element (with two director elements).

In **Fig. 3** pay particular attention to the addition of the fifth director.

Keep in mind that in each case the addition of each element was made solely on the basis of locating the element where (after all other inter-element relationships were compensated) optimum forward gain resulted.

With the addition of the fifth director, the human urge to want to locate it approximately 14-18 inches ahead of the fourth director was great, even though the antenna test range measurement equipment indicated that optimum gain was actually nearly 34½ inches ahead of the fourth director.

To the eye, the fifth director seemed to want to locate where the *sixth* should go, and a gaping hole existed in the boom position where the fifth should be!

This particular episode cost us more than a week of back tracking and re-building, but the results always came out the same, regardless of such variously tried changes as height of the antenna above ground, vertical or horizontal polarization, and so on.

The real surprise after this stage of development came with the addition of the sixth director. Our assumption was that it should locate another 34½ inches (approximately) ahead of the fifth physical director. We tried this and the field strength diminished. Attempts to position it in the general area of 14-18 inches ahead of the fifth director (as the other prior directors had spaced out) met with a very slight 4% improvement in down range field strength.

On a hunch the sixth director was placed in the "hole" where the fifth should have located, and after some small amount of inter-element juggling, the antenna gain jumped and the final positioning shown resulted!

ELEMENTS/GAIN	ELEMENT LOCATIONS/SPACINGS	NOTES/TEST RANGE READINGS
DIPOLE 0 db GAIN		FIELD STRENGTH READING 7 μA AT RECEIVING TEST POINT.
DIPOLE / REFLECTOR 5.2 db GAIN	10¾"	GAMMA MATCH CAPACITOR ADJUSTED FOR 1:1 VSWR. FIELD STRENGTH 20 μA.
DIPOLE / REFLECTOR 1 DIRECTOR 7.9 db GAIN	10¾" · 10⅞"	GAMMA MATCH CAPACITOR ADJUSTED FOR 1:1 VSWR. FIELD STRENGTH 47 μA.
DIPOLE / REFLECTOR 2 DIRECTORS 9.1 db GAIN	10¾" · 10⅞" · 16 11/16"	GAMMA MATCH CAPACITOR ADJUSTED FOR 1.15:1 VSWR. FIELD STRENGTH 62 μA.
DIPOLE / REFLECTOR 3 DIRECTORS 10.1 db GAIN	10¾" · 10⅞" · 17 5/16" · 14 13/16"	GAMMA MATCH CAPACITOR ADJUSTMENT NOT NECESSARY. FIELD STRENGTH 80 μA.
DIPOLE / REFLECTOR 4 DIRECTORS 10.4 db GAIN	10¾" · 10⅞" · 16 9/16" · 17⅜" · 15⅝"	NO GAMMA MATCH CHANGE. FIELD STRENGTH READING UP TO 90 μA.
DIPOLE / REFLECTOR 5 DIRECTORS 11.0 db GAIN	10¾" · 10⅞" · 16 9/16" · 18⅛" · 14 17/32" · 34 7/16"	NO GAMMA MATCH CHANGE. NOTE WIDE-SPACED FIFTH DIRECTOR. FIELD STRENGTH 104 μA.
DIPOLE / REFLECTOR 6 DIRECTORS 13.1 db GAIN	10¾" · 10⅞" · 16 9/16" · 14⅞" · 19¼" · 18¼" · 15¼"	NO GAMMA CHANGE. NOTE SIXTH DIRECTOR BETWEEN FOURTH AND FIFTH. FIELD STRENGTH 160 μA.

Fig. 3. Results of adding elements to a dipole. Gain is referenced against original tuned dipole.

I suspect that others have found that the fifth director in a controlled environment yagi belongs well ahead (relatively) of the fourth for there are such designs in print today in reference books. However I also suspect that other designers, upon noting this fifth-positioning, have also assumed (as I did) that the sixth would also locate the same approximately elongated spacing distance ahead of the fifth.

My extensive experiments indicate this is a mistake for in truth the sixth goes where the fifth should have gone.

This is relatively simple to verify. Remove the last director (fifth to be added—sixth in line) after the sixth to be added (fifth in line) has been positioned. Performance drops much out of proportion to the gain of the theoretical last director's influence.

Inter-element relationships

In **Fig. 2** measured current points were plotted as a function of physical distance along the path of fire of the driven element.

In **Fig. 4** these same measure points are referenced against the final positions of the parasitic elements in the six director (eight element) parasitic antenna. Note carefully where each element falls relative to the rise and fall of the current peaks plotted *before* the elements were added and positioned.

Note, if you will, that director elements 1, 3 and 5 fall on the *descending* (down) side of the current slope while director elements 2, 4 and 6 fall on the *ascending* (up) side of the same curve.

Refer to **Fig. 5.**

Here the relative position of these director elements is shown as a percentage of the physical distance from the top (or start) of the current curve in which it falls.

In the eight element yagi, for example, director number one is 34% *down* (or physical distance ahead) of the driven element, which represents the start of the first curve.

Director number two is 86% *up* (on the ascending side) of the same curve.

Director number three is 32% *down* the second curve.

Director number four is 92% *up* the second curve. And so on.

In each case the optimum spacing of the elements, and their final optimum gain settings, is a clearly recognizable pattern or positioning that corresponds precisely with the originally measured 0.6 wavelength repeating current peaks emitted by ~~the~~ driven element standing alone.

It is a relatively simple matter to reduce these observations to a formula which will allow the builder to duplicate these performance parameters on nearly any VHF-UHF frequency.

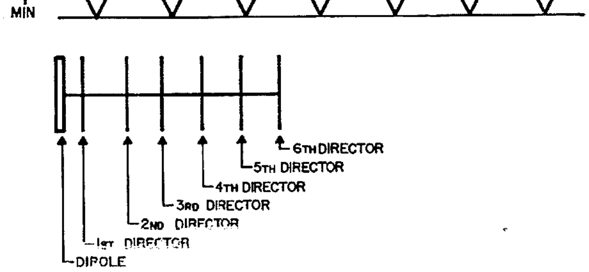


Fig. 4. Current peak on driven element alone relative to position of directors.

Spacing of Director Elements

No. elements in yagi	D1	D2	D3	D4	D5	D6
3	34%					
4	34%	86%				
5	34%	88%	138%			
6	34%	85%	133%	195%		
7	34%	85%	142%	188%	—	295%
8	34%	86%	132%	192%	249%	297%

Spacings given here are for any number of total elements up to 8, with a 0.2 wavelength reflector spacing (for maximum gain). Note the "ghost element" in the 7 element yagi.

Spacing for 100 mc Yagi

8 Elements	D1 to D2	to D3	to D4	to D5	to D6
	25.52"	35.66"	33.28"	42.94"	40.79" 34.34"

Fig. 5. Element to element spacings are given with the first D1 measurement the distance from the driven element to the first director. The total boom length required is 18.1 feet. The driven element length is 55.20 inches and the reflector to driven element spacing is 23.85 inches.

Calculating ascendency curve

(A) Determine the center frequency of the range you wish to cover. Calculate the *ascending-descending curve* (0.6 electrical wavelength in free space) by the following formula:

$$\frac{492}{\text{Freq. in mc}} \text{ divided by } 5 \times 6$$

Convert to inches by multiplying the result of above by 12.

(B) This figure, the A/D Curve, will determine the placement of all of your director elements. The spacing for the reflector will be

equal to the figure determined in (A) above, divided by 3. This is 0.2 wavelength spacing.

(C) The placement of all director elements can be determined by following the table below. In this table, everything is given in percentages in terms of the percentage of the A/D curve (0.6 wavelength) derived from (A) above. For example, as shown below, in an eight element (6 director) yagi for 100 mc, the first director will be 34% *down* the descending side of the first A/D curve, as measured from the driven element forward. 34% of the A/D curve of 5.963 feet at 100 mc is 25.52 inches. The first director, then, falls 25.52 inches ahead of the driven element, at 100 mc. The second director falls 86% along the same first A/D curve, or 61.18 inches ahead of the driven element. And the third director falls 132% along the A/D curve, or on the *down* side of the second A/D curve. At 100 mc, with a 5.963 foot A/D curve, 132% along the curve flow falls 94.46 inches from the driven element. And so on. Just remember that all calculations are in terms of the basic A/D Curve, which is computed from (A) above.

(D) Element lengths, from experience, is as follows. If the yagi is to perform over a ½ megacycle (or smaller) bandwidth, make the reflector 5% longer than the driven element and the directors correspondingly 2.5% shorter, each that amount shorter than the preceding director (or driven element in the case of the first director). If the yagi is a broadband affair, to work over a 6 megacycle wide television channel, make the reflector 5% longer than the driven element and each director 5% shorter than its predecessor element.

(E) The formula for calculating driven element length is as follows: (assuming use of 1 inch or smaller diameter tubing for the driven element at frequencies lower than 450 megacycles)

$$\text{Length in inches} = \frac{5540}{\text{frequency in mc}}$$

Finally, for reference sake, and purification of the presentation, **Fig. 6** illustrates the current peak readings made *after* the eight element yagi was completed. For reference sake the dashed line is included as the original readings taken with the driven element *alone*.

Here it is clearly evident that current relationships in the transmitted wave front are largely distorted and re-played with the addition of the parasitic elements to the single

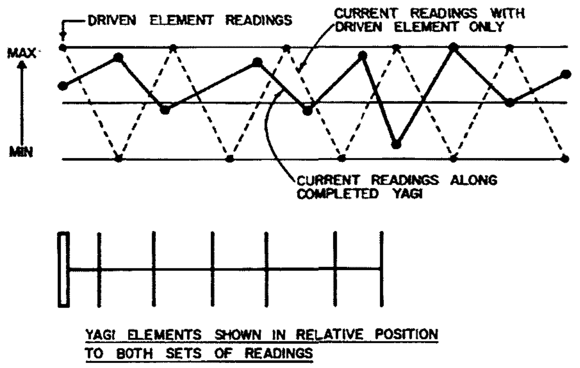


Fig. 6. Current peak readings made after the eight element yagi was completed.

element driven-element antenna. Interestingly enough, the roles of the odd numbered directors (1, 3, 5) and the even numbered directors (2, 4, and 6) have *reversed* in this antenna field comparison. Whereas the odd numbered directors formerly fell on the *descending* side of the *driven-element only* current curves, they now fall on the *ascending* side of the new curve. And the opposite is quite true for the even numbered directors, falling as they do now on the *descending side* of the new set of curves.

The logical extension of this approach to yagi antenna design is simply this. That in any parasitic antenna configuration, the current distribution within the field of the antenna is extremely critical. *The proper phasing of these antenna currents is of even greater importance.* Experience with other yagi design formulae indicates that some benefits are to be derived from almost *any* design, although it would seem logical that hap-hazard design approaches to extremely long yagis is an excellent way to end up with less forward gain and directivity than you might reasonably expect from a well designed three element antenna.

Yagi gain, then, appears to be a matter of degrees. The amateur who wishes to verify the design parameters of an existing yagi antenna needs only to set up a reasonably pure test range, and feeding his test antenna with a low power signal (100 milliwatts is fine for this purpose), observe the cumulative results as elements are added to, or moved or removed from the antenna under test.

Removal of any director element and a corresponding *rise* in indicated field strength at the test receiving site, or no change at all is a good indication that all is not well in the current phasing region of your parasitic yagi antenna!

. . . K6EDX

Paul Franson WA1CCH
Peterborough, N.H.

The Uhfit

A UHF wavemeter, detector, field strength meter, monitor, multiplier, filter, converter etc.

The other day, a visitor told me that he wanted to get on 432 mc, but hadn't because it's too expensive, too hard, too much trouble, too complicated, too difficult to find equipment and too time consuming.

That's ridiculous. Anyone who can solder can sit down for a few minutes with a few scraps of metal and a few other parts and build himself useful pieces of UHF equipment. This article describes one I call the uhfit (for UHF unit).

The uhfit can be used for finding bands, tuning transmitters and antennas, monitoring signals, filtering out unwanted signals (and filtering *in* wanted ones), mixing for converter use, multiplying signals for local injection or test generator use and many other tasks.

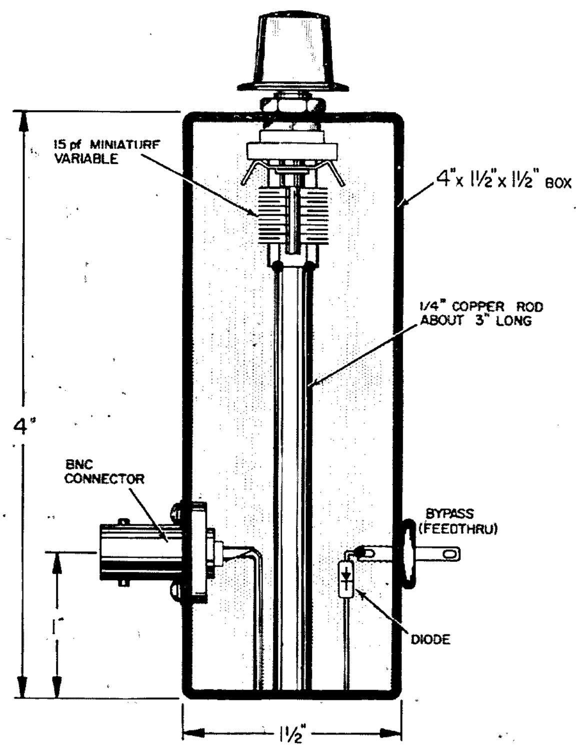


Fig. 1. The Uhfit—a UHF multi-purpose unit. This is the basic wavemeter-field strength meter. Modifications for other uses are described in the text.

So what is the uhfit? It's a simple tunable trough line cavity tuning 210 to 470 mc. Various "accessories" such as antenna jacks, diodes, wire links, transistors, feedthrough capacitors and other components are added for specific purposes as outlined in this article. The uhfit covers the 220 mc band for individualists, UHF aircrafts, the 420-450 mc ham band, the 460 mc citizens band and lots of whining radar.

Construction of the uhfit

The uhfit is most easily made from copper clad laminate board with the copper on the inside, but it can also be made from other materials. Probably brass makes the prettiest box; copper is nice but a bit soft. You can even use old tin cans. Tin isn't the best of conductors, but good solder is 63% tin and not many people bother to lose sleep over that. An advantage of solid metal over the copper clad board is that you can put a cover on the uhfit for neatness, higher Q (probably), and to keep the bugs out. There will be a small change in frequency range if you use a cover. I built my uhfits from the copper clad board and didn't put a cover on because of the mechanical problem of getting a good electrical contact.

The center conductor is a piece of copper or brass rod about 3" long. You can often find pieces of it in old TV sets as shaft extensions and most hardware stores carry it too. Be sure to tin the ends of the rod and the matching part of the box before you try to stick them together. The best soldering tool for this—or any soldering—is an Ungar 47½ watt long chisel tip.

The variable capacitor is not too critical. I used a small Johnson or Hammarlund miniature variable in mine, and some surplus capacitors are real nice. If you use a smaller capac-

itor, the minimum frequency will be higher, but the maximum won't change very much since most of the small capacitors have about the same minimum capacitance. Conversely, if you use a slightly larger capacitor, the minimum frequency will be lower than 210 mc, but the maximum frequency will decrease quickly since miniature capacitors over about 15 pf aren't very small. See the section on other frequencies if you want to fiddle.

We're now to the point where you have to decide what you're going to use the uhfit for. Chances are you'll want and need the basic wavemeter-field strength meter most, so I'll describe that first.

Fig. 1 and **Fig. 2** show this basic uhfit use. In addition to the trough line cavity, you'll need an rf connector, some heavy wire, a diode and a feed through capacitor. I like BNC connectors. They are excellent electrically, easy to connect and disconnect, and plentiful. You can pay 35¢ apiece for them surplus, but most hams don't. Fairly modern surplus seems to be covered with them and a good scrounger can get all he needs for very little. If you want to use other connectors, RCA phono type are probably as good as any for this use.

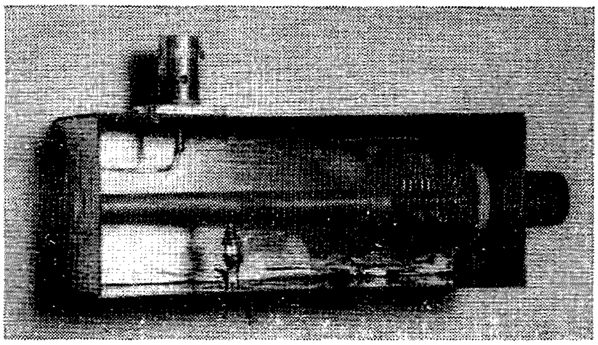
The feedthrough bypass capacitor is not critical. Values from 100 to 2000 pf seem fine. There are many different types available from surplus, new, and from old TV tuners. Be fairly gentle with them since they're fragile. If you want to buy a new one, the Centralab MFT-1000 for 30¢ from most distributors seems about as cheap as any.

I used a 1N82 diode in some of the uhfits, a 1N295 in others, and some unmarked detector diodes in others. I also tried many miscellaneous computor types out of curiosity and satisfied my curiosity. Stick to diodes designed for VHF and UHF use. Transistors Unlimited and others sell them at very reasonable prices. Solder these diodes quickly as they're not fond of heat. VHF transistor collector-base and emitter-base junctions can work well, too, if you happen to have more VHF transistors than VHF diodes.

The loops for the antenna input and the diode aren't critical for most uses. You can even eliminate the loops and tap directly on the center conductor if you prefer, though that will broaden the tuning and change the frequency range somewhat.

Using the uhfit wavemeter

It's very simple to use the wavemeter once you have it calibrated. For that, see the section on calibration. Connect an antenna—usually a short piece of wire—to the antenna jack and a meter to the bypass terminal and case of the uhfit. Use a sensitive meter or meter and amplifier (see the article in the January 73 for some excellent amplifiers) for low power oscillators and transmitters or a low range voltmeter or milliammeter for high power transmitters, but don't try to get too much or you may bake the diode. Then just tune the wavemeter for maximum output. You'll quickly notice that tuning is very sharp. In fact, you'll probably try to figure out a vernier arrangement or at least use a big knob after you've used the uhfit for a while.



The Uhfit. Note that the diode is tapped on the tuning line. It was later found that a link was better for most uses.

The uhfit as a field strength meter

The same arrangement is used here. Connect an antenna to the antenna jack and tune for maximum meter reading. Use any old piece of wire for rough tuning or a carefully made, balanced, isolated, matched dipole for antenna measurements.

The uhfit as a monitor

The uhfit can be used as a monitor of signal strength by connecting it to an antenna near your transmitter antenna. Then a meter in your shack will tell you instantly if something goes wrong with the transmitter, transmission line, or antenna.

You can use it as an AM monitor by connecting a pair of headphones to the output jack if your signal is strong. If not strong enough, use a 1 k to 1 M load resistor across the output jack and amplify the signal there with an audio amplifier such as one of the Lafayette $5 transistor ones. The feedthrough capacitance and load resistor should be compatible in regards to time constant; if that statement doesn't mean anything to you, don't worry about it unless the audio sounds "bassy". Then try a larger load resistor, or smaller feed

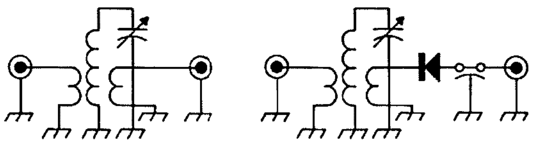


Fig. 2. Two uses of the Uhfit: a high Q tank to help eliminate unwanted frequencies, and the basic wavemeter.

through or check your transmitter which may *be* bassy. You can also use the uhfit as an audio detector for the horizontal plates of your scope.

You can monitor SSB signals with the uhfit if you happen to have a very stable oscillator to inject a carrier, but I wouldn't build the uhfit just for that.

The uhfit is good for monitoring CW if you have enough voltage output to key a small transistor oscillator.

ATV? Sure. Use the same scheme as monitoring AM if you like to listen to video signals. Come to think of it, they tell me that some devoted RTTee's can copy teletype in their head. Maybe ATV'ers see the pictures when they hear video. . .

More useful might be to connect the output of the uhfit to the Z axis of your scope. You might have to reverse the diode if you don't like negative pictures. For horizontal and vertical sweep, you might be able to use the scope itself since you may be synched on the 60 cycle AC line in one way or another in this age of interconnected power lines. You'll probably have to clip off some sync pulses with diodes or transistors and reduce the feedthrough capacitance. I haven't tried it.

You can also use the uhfit as a simple AM receiver for nearby planes or hams. Don't forget that that's not legal in the VHF contest anymore, though.

RF filter

This use of the uhfit requires a slight modification from the above uses. It's shown schematically in **Fig. 2** as a hi-Q tank. Use another rf connector and loop instead of the feedthrough and diode. Then the filter can be used in receiving to help keep unwanted signals—especially images and strong locals—out of your converter. Use large coupling loops for minimum degradation of your noise figure, and small loops for maximum rejection of spurious signals. These small filters don't work as well as large, silver plated coaxial ones, of course, but they do a pretty good job.

The same considerations apply for transmitting. The filters will help prevent UHF TVI or AFI (air force interference, very bad) if you use a varactor multiplier on 432 mc without an amplifier. Don't try to feed too much power into the uhfit, of course.

The filter is also good for tuning up transmitters. Put it between the transmitter or multiplier and the dummy load to make sure that the power you're measuring is on 432 mc and not 288 mc or somewhere else.

Diode multiplier

In the basic uhfit, use a varactor or UHF diode (such as the Amperex 1N3182 at 85¢) and rf connector instead of the detector diode and feedthrough. Here's one case where it's good to tap onto the line instead of using a loop. Feed rf into the varactor rf connector (input) and tune the capacitor to twice or thrice its frequency. This provides a low level multiplier for local injection in a converter or a test signal. A resistor of 47 k to 1 M from the low frequency side of the diode to ground improved results for me.

Mixer-converter

To make a simple converter from the uhfit, you'll need two loops with rf connectors, and one loop with a UHF diode and a low capacitance feedthrough capacitor (say 50 pf). You can easily make a capacitor of that value from a small piece of double copper clad fiber glass laminate or what have you. While it isn't critical since this converter isn't going to set the moon on fire, a convenient arrangement is to put the other loop behind the center connector.

One rf loop is for the antenna. The other is for the local injection. The loop with the diode is the mixer and the output from the feed through is your *if*. Resonate a coil of wire with the feedthrough capacitor at the *if* you choose and use a loop of wire to couple to your *if* receiver.

For narrow band work, you can use a simple crystal controlled local oscillator and multiplier. The best *if* for this would be a low noise six or two meter converter. For ATV, use a simple one transistor local oscillator and your TV set as an *if*. For wide band, modulated oscillator use, a superregenerative receiver such as the Sixer or Twoer or a cheap FM receiver is a good *if*. Good FM tuners (like my Scott) do too good a job of rejecting AM and you lose part of the modulation.

No one claims that this type of converter

is the ultimate. However, with fiddling and/or a transistor preamplifier or two, it can do a very good job.

Tunable oscillator

The uhfit can also be used as an oscillator in a simple adaptation of the UHF dipmeter in the December 73. Simply use two feed-throughs (as in that article) and connect the collector lead about an inch or two up on the center line. Use a small loop for output. That gives you a simple UHF signal source, tunable local oscillator or low power transmitter. If you want to modulate the oscillator, you'll get mostly FM. Transistor oscillators love to FM. Don't expect too much.

Different frequencies

If you want to cover lower frequencies, your best bet is to make the box larger, the line longer and use a larger capacitor. I didn't try to get lower than two meters.

Higher frequencies are more fun. For 1215 to 1300 mc, make the box about one-third as long, but the same width and depth. Use a brass screw or brass core from a broken coil form with suitable nut or bushing as a capacitor. It provides just the right amount of capacitance as it goes into the open top of the line. Be careful that it doesn't short or you'll have a half wave instead of quarter wave line and twice the frequency.

For fixed frequency use in converters, etc., a glass or ceramic piston trimmer is far easier to tune than a variable air one since they provide at least a ten to one bandspread.

Calibration

Calibration of the uhfit is easiest with a tunable calibrated oscillator such as the UHF dipmeter in the December 73. Of course, you need a wavemeter to calibrate that. . . Chances are that someone around you has one or the other. If people who volunteer to help calibrate wavemeters or dipmeters will send me their names and addresses, and those who want help will send a self addressed envelope or postcard, I'll try to get you together properly.

And finally, I make no claim for any originality for any of this, though none is taken from any rememberable source as I have a spongy mind. I also don't claim that the uhfit is the ultimate in UHF equipment, but it's simple, cheap versatile—and fun! Why else build anything, . . . WA1CCH

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A Home-Brew Permeability Tuned VFO

For something like twelve years, I've been trying to build a good VFO. Unfortunately, such is the nature of Genus Hammus that after I built each one my requirements became stricter. A friend once told me that what I wanted was a crystal—with a knob on it. Actually, I've tried that, but the range is too limited. I replied, wittily, that all that I needed to build what I wanted was: a case built like a battleship, a device with power gain that produced no heat, and a variable reactance that wasn't subject to vibration.

To some extent the features that I wanted are incorporated in the present VFO, and the result is pretty good. I built it out of scrap material using hand tools and a quarter inch power drill. The VFO drifts only a few cycles from turn on, has plenty of bandspread and is practically insensitive to vibration.

The oscillator uses basically the Clapp circuit. The capacitive swamping is not as heavy as usually used, but this seems to have no bad effects in this case.

Circuit

The circuit as shown has been tested with various inductances and capacitances and oscillates up to 25 mc. It would probably work above that frequency.

The transistors are 2N708's. These are NPN silicon high frequency transistors operated in this circuit at very small fractions of their ratings. At least one manufacturer sells these at less than $1.50 each. Other similar transistors will undoubtedly work in the circuit, but the 2N708's are about as inexpensive as any readily available which have good high frequency characteristics.

The oscillator is followed by an emitter follower. This is followed by a class A amplifier which is followed by another emitter follower for low impedance output to a cable. The VFO shown will produce a useful voltage across a 50 ohm load. A 75 ohm load gives a little more voltage still.

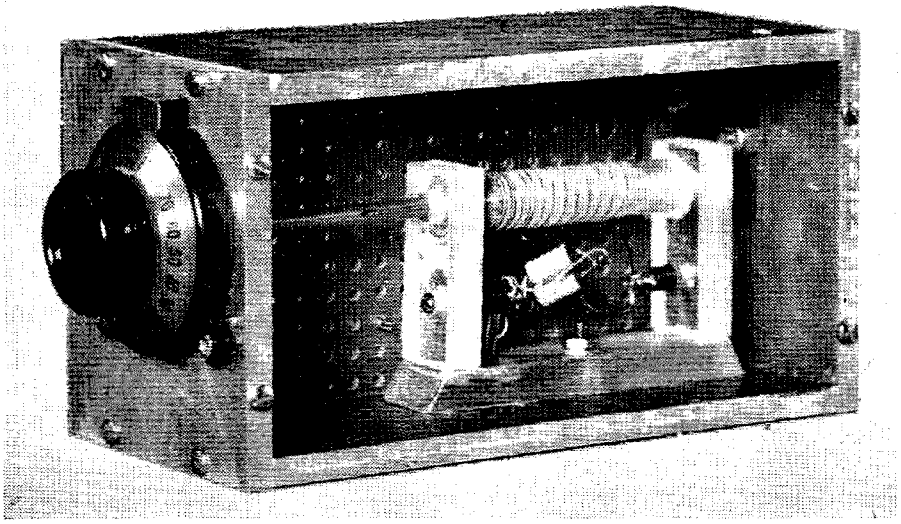
It is not, of course, necessary to use the permeability tuning shown with this circuit, but the series capacitance should be kept fairly high for oscillation to start readily if a variable capacitor and fixed inductor are used.

W4VRV is an Asst. Professor of EE at Clemson on leave to Ohio State while he's working on his Ph.D. and their radio observatory. He likes to design and build VHF gear.

Mechanical details

The circuit is built on Vector board using flea clips. Standard components were employed throughout, and no difficulty was encountered due to any unwanted couplings. The transistors are soldered in (after mounting *all* the other components to the flea clips). The silicon transistors are very tolerant of heat, but the iron should not be applied to the leads for more than about five seconds. That will be more than enough. No heat sinks were used.

The box used in this case to house the unit was made from ¼" aluminum, top, bottom, front and back, with ⅛" aluminum sides. This is undoubtedly overdoing the rigidity bit, but it was available. A sufficiently rigid enclosure can be made from ⅛" aluminum (rack-panel type) with angle stock at the corners (do it yourself stock available in hardware store or from Sears, Roebuck). A Minibox might do, but I've never found them rigid enough for VFO's. Look at the construction of a BC221, for example.



The heart of the VFO, L1, a permeability tuned coil wound on thick plastic stock.

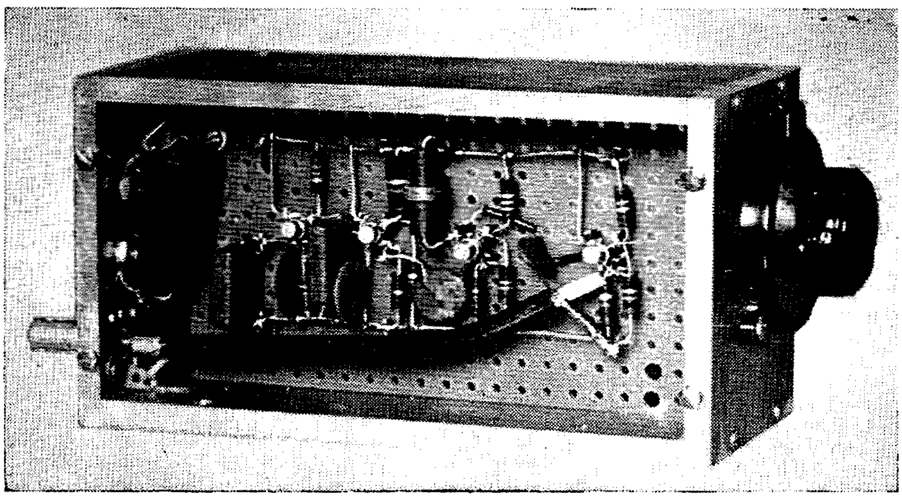
Use batteries for the power supply. The VFO frequency varies with voltage and even with a well regulated laboratory type AC supply some FM could be detected as a rough note at the 5th harmonic. Batteries smoothed it right out. Three "D" size flashlight batteries should last quite a while since the drain at 4.5 volts is 3 ma. This figures out to a total power input to the VFO of 13.5 milliwatts, which is one of the main reasons for the stability. There's practically no internal heating.

The inductor

To keep changes in the box from stretching the coil from the inductor is constructed to be supported by the box at only one point.

The slug, which gave the inspiration for this mode of construction, is from an old ferri-loopstick broadcast coil ¼" in diameter, with a 4-40 screw on one end, and a hole the right size to take a 4-40 screw in the other.

The bass and uprights were constructed from rectangular plastic stock ⅝" x ½". The coil form itself is ⅝" round plastic. A hole ¼" in diameter was drilled through the center of the coil form and then smoothed slightly by wrapping fine sandpaper around a smaller drill and working it back and forth until the slug slid easily through the form. When plastic is drilled with a high speed drill it tends to grab and melt and otherwise behave badly, so the drilling should not be rushed. The centering of the hole exactly is not extremely important, but it should be straight and as parallel to the form as possible. One end support was then glued on with polystyrene cement and the ¼" hole continued through the coil form through the support. (Let the cement harden thoroughly first.) Both supports are then glued to the base and the coil form glued to the other support. After drying, the hole is drilled back through the first support and coil form and through the remaining support. This



View of the transistors in the VFO. Note the solid construction.

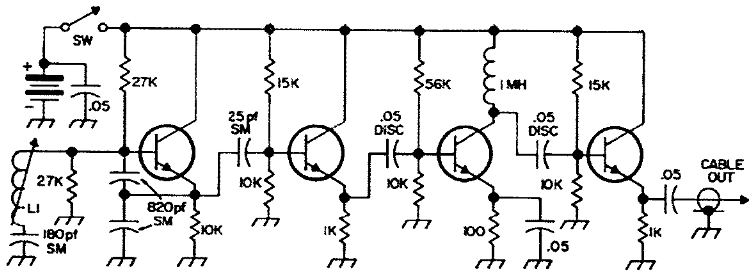


Fig. 1. A Home Brew Permeability Tuned VFO. See text for L1. All transistors are 2N708. Battery voltage is not critical; a 4.2 volt mercury battery is recommended for best performance.

way, all the holes line up exactly.

A 4-40 nut is then put on the screw in the slug and the slug is slid into the form. The nut is then heated with a soldering iron until it melts securely into the support. Another 4-40 screw, at least two inches long is then threaded an inch or so into a nut, and ¼" or so of its threaded end is liberally smeared with epoxy cement. The hole in the slug is also smeared on the inside with epoxy cement for about ¼". (A toothpick serves well.) The slug, in the coil form, should then be positioned so that when the nut on the two inch screw is melted into the remaining end the screw will go into the hole for about the ¼" that has been glued.

Once assembled in this fashion, the nuts, screws and form will be in alignment, and the slug should revolve freely for ¼" or more of travel inside the form. Unfortunately, once assembled in this fashion, it is impossible to take the assembly apart without breaking something, so be careful!

This may sound involved, but once the drilling of the form and supports is completed and the plastic cement has hardened, the remaining steps take about as long as it takes to tell about them. The important thing is the order of assembly—which should be fairly obvious.

The coupling from the dial to the inductor is a piece of tubing with an inside diameter that the 4-40 screw on the slug will slide inside. The tubing is slotted (with a coping saw) on one end, and built up with wire on the other to fit the ¼" hole in the dial. A short strap is soldered into the slot in the screw on the slug. This strap rides in the slot as the slug rides in and out and serves to transmit the circular motion from the dial to the slug. This method of construction also avoids transmitting any lateral motion to the slug due to the expansion of the case from heat.

The winding was put on the form and cemented with Q-dope. Since I was only interested in proving a point, rather than absolute linearity, only an approximation was made to a winding that would give the ultimate in linearity. Even so, one revolution of the screw gives 35 kc at one end of the range (5 mc) and 50 kc at the other end (5.8 mc) with the winding as shown. Further adjustment of the spacing of the winding before gluing would have improved that. This particular frequency range mixes with my 9 mc filter output for eventual use at 50 mc.

The winding in use is twenty-seven turns of #22 enamelled wire. The first ten turns are close-wound, and the next seventeen with gradually increasing spacing. The spacing between the last few turns is about 3/16".

Results

The resulting tuned circuit is temperature sensitive because the dimensions of the ferrite slug are temperature sensitive. However, the input to all four transistors is around a tenth of a watt, and the oscillator shows no discernable drift caused by internal heating during operation.

Uncompensated for temperature, the VFO was taken from a cold car into a heated room, hooked to a counter and turned on. The drift was down in frequency and steady, about ten cycles per minute. The VFO was turned off and left in the room for a couple of hours. Turned on again, after reaching room temperature, the total drift was 150 cycles in 24 hours from a cold start. If the temperature where the VFO is to be used is not steady, some form of temperature compensation should be employed. Negative temperature coefficient capacitors should do nicely here.

As currently constructed, the VFO has several drawbacks. There wasn't enough heavy aluminum available to build the box big enough to put a good turn-count dial on it. A ten turn Revodex dial has been tried, but is not entirely satisfactory. The output voltage is only a volt or so rms. For use with a mixer, this is enough voltage, but if the VFO is to drive a crystal oscillator stage, another stage of amplification will be needed. The input resistor in the grid circuit of such an amplifier stage could be 100 ohms or so, thereby removing the necessity for neutralization.

. . . W4VRV

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A Receiver VFO Controlled CW Transmitter

After working a contest or two it doesn't take a wise amateur long to understand that time is a premium. A kilowatt helps to bring contest points, but with the advent of highly selective receivers and crowded ham bands high power often goes unheard. Like snatching cola bottles out of the cases as the delivery truck drives by, contest operators have to be fast, smooth, and on frequency. And needless to say if we have our transmitter exactly on frequency at all times and are taking up only one frequency on the band there is that much more room for QRM free operation of other stations. With this in mind I realized that I needed a rig that was not commercially available.

There are a few store bought rigs that have transceive operation but most are designed exclusively for SSB or are designed for SSB and include CW operation as an add-on feature which has been given little consideration. Shortly before beginning construction on the rig described herein I practically gave away a $2000 transceiver with atrocious VOX keying and a transmitter that was always 1.3 kc off frequency.

A glance at the block diagram of my transmitter (Fig. 1) will bring to visualization what is happening inside the transmitter. The

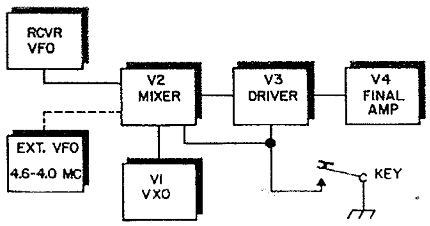
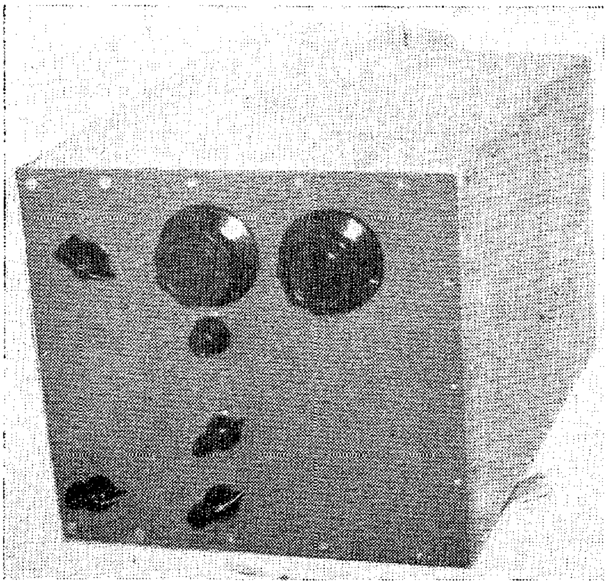


Fig. 1. Block diagram of the receiver VFO controlled CW transmitter.

variable crystal oscillator generates a signal which can be varied several kc either side of the frequency which brings the transmitter in exact coincidence with the receiver. This we will call the center-frequency. In my particular case I am using a Drake 1-A receiver with a 4.6-4.0 mc vfo. This signal source is tapped directly at the grid of the mixer tube it is feeding and cabled out of the receiver by means of high impedance microphone cord and phonograph connectors. Capacitive coupling is used to bring the rf to the signal grid of V2. If you don't like the idea of delving into your receiver to pull out the sample of rf needed to excite the mixer you can easily modify your existing vfo, or any external vfo to operate on 4.6-4.0 mc, or whatever frequency you desire, other than one in the ham bands, and still have the advantage of a fine heterodyne, grid-block keyed exciter. Many will be interested in using both the receiver vfo and a separate one for cross-band operation, chasing DX etc.

By applying the VXO output to the injection grid of V2 we get the desired operating frequency along with various image signals and harmonics of the two inputs. When figuring the proper VXO crystal center frequency for use in conjunction with your receiver be sure that none of the harmonic or image frequencies fall much closer than 10%-15% of your operating frequency. To determine the VXO crystal center frequency if your receiver vfo is above the received signal frequency, subtract the received frequency from the vfo frequency. If it is below, add the received signal frequency to the vfo frequency. For example in the case of the Drake 1-A, when its vfo is tuned to 4.6 mc the received signal frequency is on the low edge of the ham



Front view of the transmitter.

bands, in order to determine the VXO crystal center frequency on 40 meters we add 4.6 mc and 7.0 mc to get 11.6 mc. As the vfo is tuned lower in frequency the transmitter frequency will raise, 4.6 mc gives a tran$mitting signal of 7.1 mc, and 4.2 mc brings us to the top edge of the band.

V3 serves as both an amplifier and a device to filter out undesired signals with both grid and plate tuned circuits.

At this point it might be interesting to note that the sub-assembly chassis that V3 is on was originally a Geloso all-band vfo, and the 5763 was used in it as an amplifier stage. The tube socket that V2 is in was original and held a 6CL6 previously. V1 was mounted in an empty space forward of the 6BA7. Other components supplied by Geloso are, the slug-tuned coils, their associated trimmer condensers, the VXO tuning capacitor, which was first a vfo grid circuit part, and assorted resistors and by-pass capacitors which just happened to be heeded in the new circuits. For those who have an unused Geloso vfo kicking around you might employ it's compact chassis in the construction of your version of this transceiver. If you don't you might go out and buy one, they are relatively cheap. The V2 plate circuit slug tuned coils were left untouched as far as taking off any turns or re-winding them. However, they were taken out of the single ended circuit and used in a pi-network with a 140 pf capacitor added on the plate side to tune them to resonance, and a fixed 100 pf capacitor placed

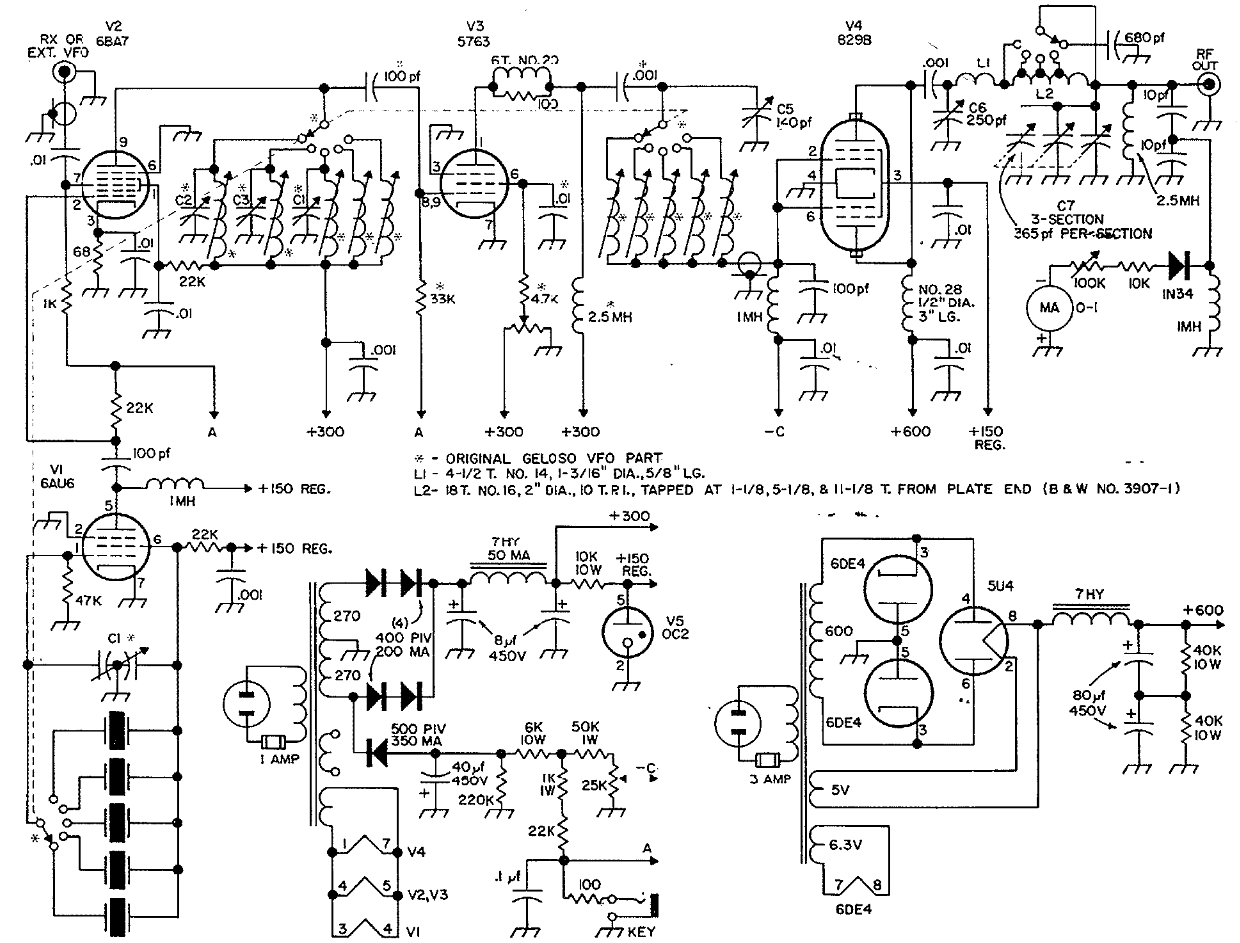
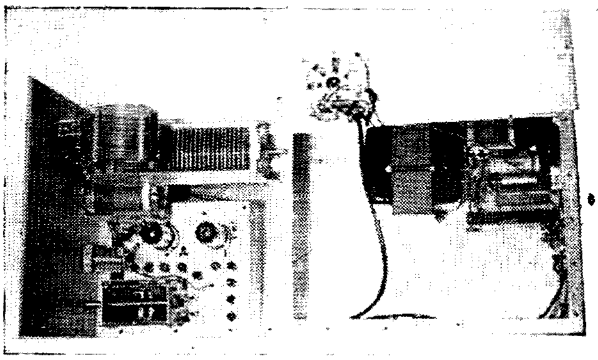


Fig. 2. Schematic of the transmitter. Note that many of the parts used came from a Geloso VFO, but can easily be found elsewhere.



Inside of the transmitter.

in the output side. These fixed 100 pf's are soldered directly across the final's grid to ground, this helps to stabilize the amplifier. The coils were re-adjusted to bring them to resonance in their new application. Mr. Geloso used five other slug-tuned coils, three of which were selected to determine vfo fundamental frequencies, the other two were used in the plate circuit of the vfo tube. All were re-wound and grid-dipped to the middle of each ham band in use. On 80, 40, and 20 meters three air trimmers which were all ready on the chassis were tied across these coils for padding. The vfo tuning condenser had three ganged sections on it, two were wide spaced, one with a few more plates than the other, and the third had a thick, closely spaced plates. The thick plated section was ignored and not used, the larger value wide space job needed a few of its plates jerked to make it equal in value to its counterpart. This is easily accomplished by merely pulling on them with a pair of needle-nosed pliers. The resultant product, if everything goes well, can be used to vary the load on the VXO crystal and thereby encourage it to oscillate on a slightly different frequency, and give us a transmitted signal several kc either side of center frequency.

Probably by now you are wondering just how far can we vary this little VXO gem. This depends on the crystal frequency and the effective circuit capacitance. We purposely control the grid-to-ground and screen-to-ground capacitance to get the desired effect with the modified Geloso vfo condenser. Its value is somewhere around 10-50 pf per section.

The final amplifier, V4, uses an 829B with its sections in parallel, 600 volts on the plate and has a pi-network tied on the end. This stage was designed to drive a pair of 4E27A/5-125B's in grounded grid and has no wide range matching condenser in the pi-output end. Fixed micas are switched in place by the tank coil switch and were chosen experimentally. However I've calculated the necessary values to be used for matching a wide range of impedances and they are drawn into the schematic.

The 600 volt power supply is external and is actually the rectifier power unit, PP-115A, out of a TRC-8 450mc transmitter available through surplus channels. A suggested power supply is shown in the schematic and is taken out of the Radio Amateur's Handbook. Voltages of +250, +150 regulated, —40 to —60, and 6.3 ac are derived from the built-in supply in the bottom rear of the rig. Silicon rectifiers were used to save space, eliminate heating, and besides they are cheap.

Extensive shielding was used in cabinet construction, a trapped lady bug would never find her way out of the enclosure, neither will any frequencies in the VHF range. Sheet metal screws are spaced no farther than two inches apart to maintain a tight electrical seal. Reynold's do it yourself angle stock was used to support the finely perforated sheet aluminum which was procured locally. The chassis is a 3x7x17 inch Bud which turned out to be a little bigger than neccessary, but gave me plenty of working room and space for additional things such as a T-R switch, low-pass filter, or maybe a simple SSB generator. ⅛ inch aluminum plate was used for the front panel and helps support the frame.

Other than peaking all L/C circuits to resonance before trying the rig out, adjustment of the final's grid bias voltage is all that is necessary to get it in operation. No tune-operate switch was incorperated in the rig, nor was any plate, grid, or relative output indicator. In order to tune, merely turn the V3 screen voltage potentiometer-drive control so that the screen is on the ground side of the pot, and peak the driver plate tuning, C5, and final plate tuning along with the pi-output capacitor for maximum reading on your s-meter or relative output indicator (which is also thrown into the schematic). Then advance your drive control to just below the point where full output is realized and re-peak the final plate tuning. With the receiver in a high selectivity condition, and the bfo on zero, (the position where you hear the lowest pitched back-ground noise), key the transmitter and turn the VXO frequency control until the transmitter frequency falls exactly into the peak of the selectivity skirt. This will bring the transmitter in exact coincidence with the receiver providing you have the VXO on the right side of zerobeat. If you don't, give it a crank down through zero beat and back on the other side and once again into the selectivity skirt.

. . . K6REU

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The Matchmaker Circuit

An idea article

How'd you like to build an automatic antenna tuner that would follow your VFO up and down the band? Remotely, even 'way out in your back yard? Well, this *Matchmaker* circuit, as I call it, makes this possible.

This is not a construction article. Because few builders follow the original design anyhow, changing and substituting parts to suit the junkbox being standard ham procedure, I am just going to explain the circuit, its applications, and the few precautions needed.

The circuit is an adaptation of the VSWR bridge circuit, and depends on Ohm's law (E/I equals R) for its operation. That is, regardless of power (watts), the *ratio* of voltage (E) to current (I) is always the same for a given resistance. In the Matchmaker this resistance is that of the feedline.

The schematic of the bridge is shown in **Fig. 1.** There are two separate measuring circuits, you will note (separated by the dashed line), arranged to produce two outputs of opposite polarity, which are compared on a zero-center meter. One measures a portion of the line voltage, the other measures the voltage across a 1-ohm resistor in the line, which is equivalent to the current. A variable capacitor adjusts the portion of line voltage measured to the right ratio for the feedline used.

This circuit is inserted in the antenna tuner between the coax line from the transmitter and the tuning units. Then, when the tuning unit is adjusted so that the antenna exhibits an impedance equal to that to which the circuits has been adjusted, the output of the two measuring circuits will be equal and cancel each other, so the zero-center meter will read zero. Furthermore, if the antenna impedance is too high, the meter will go off center one way, and if the impedance is too low, it will go off center the opposite way. Which way it goes will depend on diode and meter polarity.

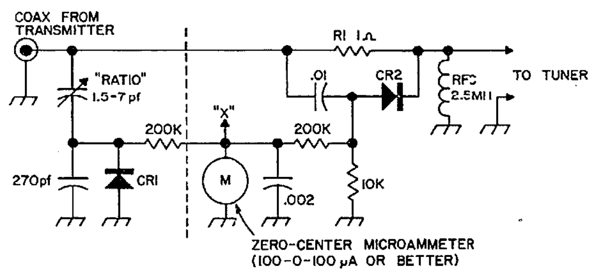


Fig. 1. Schematic of the Matchmaker bridge.

This feature makes an automatic antenna tuner possible. If a resistor of, say one-half megohm is connected in place of the meter and the voltage across it fed into a dc amplifier such as shown in **Fig. 2**, the output can, through relays, control a tuning motor. In **Fig. 2**, if the input is positive, the plate current to V1 increases and V2 decreases, so the balanced polar relay actuates the "Forward" motor relay. If the input is negative, the action reverses, and the "Reverse" motor relay closes. These motor relays are three-pole, single-throw types, with two poles connecting the motor field properly for forward or reverse, while the third applies power to the motor.

The relatively simple circuit of **Fig. 2** may not be sensitive enough with available polar relays, so I would like to suggest a system such as **Fig. 3** for those who understand transistors. No values are given for the components of either circuit because so much depends on what you use for tubes, transistors, relays, etc. Nor can polarities be assigned, for the same reason. Just be sure the motor turns the tuning unit the right way to reach the null and stop in tune.

The values given in **Fig. 1** are about right for medium power (150 watt) transmitters. For lower powers, the two 200 k resistors can

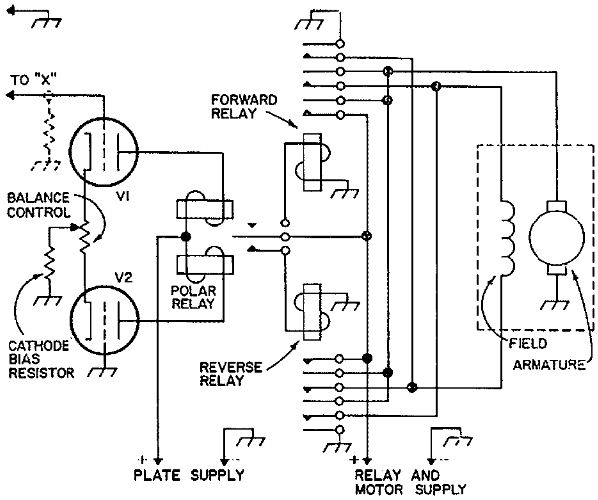


Fig. 2. Automatic antenna tuner.

be reduced to 50 k, and for higher powers they can be increased to higher values. R1, the one ohm resistor, may best be made up of ten one-watt, non-inductive, ten-ohm carbon resistors, connected in parallel in birdcage fashion. (In case you don't know, carbon resistors have color bands all the same width, while the wirewound (inductive) type have the first color band extra wide.) It helps if you can put CR2 and the .01 μf capacitor inside the "birdcage" of resistors. Other combinations of resistors for R1 are permissible. The total wattage can be decreased for lower power or increased for higher power.

CR1 and CR2 can be 1N34A's or any similar type of germanium diode good for 20 to 30 volts at one or two ma. The 2½ mh choke serves as the dc return for CR2. Short leads to the coax input connector are necessary, and compactness and some shielding from the rest of the tuner are desirable. Otherwise no particular precautions are needed in construction.

Adjusting this "Matchmaker" can be done either of two ways. A non-inductive dummy load with a resistance equal to the feedline impedance is connected temporarily in place of the antenna tuner. Then power is fed through the line at an appropriate frequency and the variable "ratio" capacitor is adjusted carefully until the output at point "X" is zero as read by a zero-center meter as in **Fig. 1**, or by a VTVM or VOM. Or an SWR indicator of correct impedance can be connected in the coax line and the antenna tuned up for minimum SWR, and with normal power supplied the antenna, the "ratio" capacitor is adjusted as above.

It is only fair to state that the Matchmaker circuit is not the complete answer to a wide-range automatic antenna tuner because it fails

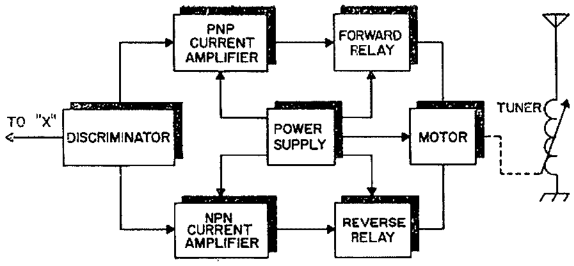


Fig. 3. More complex and sensitive antenna tuner.

to distinguish between resistive, inductive, and capacitive impedances. While there are circuits that will do this, they get a bit involved, and anyway the circuit shown will easily 'track' with a vfo over an amateur band if the LC values are properly selected to avoid reactive nulls in the tuning range. Band-switching of the tuner is not too difficult if multi-band operation is desired.

Interesting circuit, isn't it? Even used as an indicator it will tell you if the antenna impedance is too high or too low. Changes in power input merely change the magnitude of the error reading, never the zero point, so AM, CW, or SSB have no effect on its null point.

OK, engineers! Build yourself an automatic tuner!

. . . WØOPA

"Yes, he's home—but you can stay the whole weekend—he's in another of those wonderful contests . . ."

Bob Heil K9EID

Six to Two Transmitting Mixer

This simple unit will put a low power six meter signal of any mode on two. Perfect for SSB or Sixers.

The trend today in VHF amateur equipment is toward use of commercial SSB exciters and adapters. But one thing missing among the many lines of equipment manufactured is a unit that will allow the amateur to use his 50 mc equipment on two meters.

Yet this can be done very easily and effectively without any modification of the six meter transmitter if you use a transmitting mixer and use the exciter to drive the mixer. Receiving can be easily handled by a simple converter which takes its local injection from the oscillator in the transmitting mixer unit via the oscillator output jack.

The mixer shown here (**Fig. 1**) gives tremendous supression of unwanted signals. It uses a 6360 tube as a mixer and a second 6360 as a class AB1 amplifier to give an output of 15 to 20 watts PEP. This is plenty of power to drive a linear or to use barefoot and many wonderful contacts have been made with this unit without any additional amplification.

Construction is very simple and easy if you follow the photos. Proper shielding between stages is very important to tame the unit so that it won't take off on its own as some mixers do. The shields can be made very easily from sheet copper or copper clad board.

L2, L3 and L4 can all be made from one piece of B and W stock by removing a single

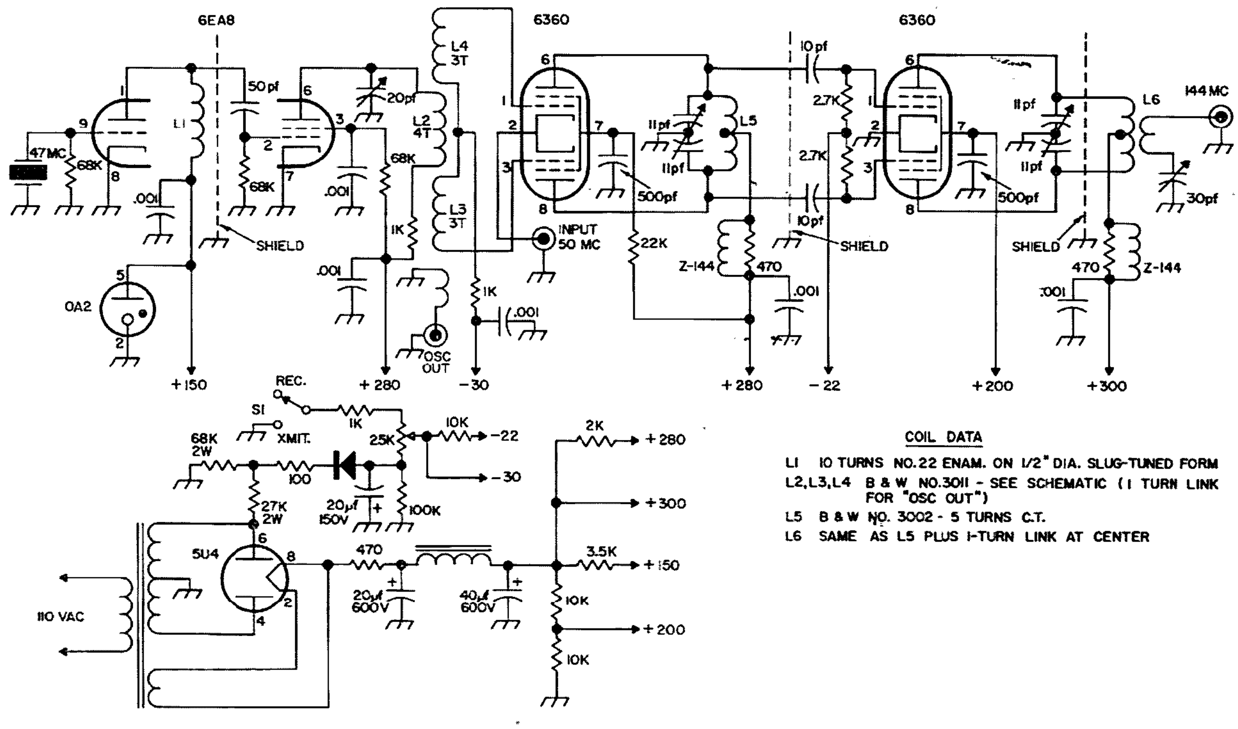
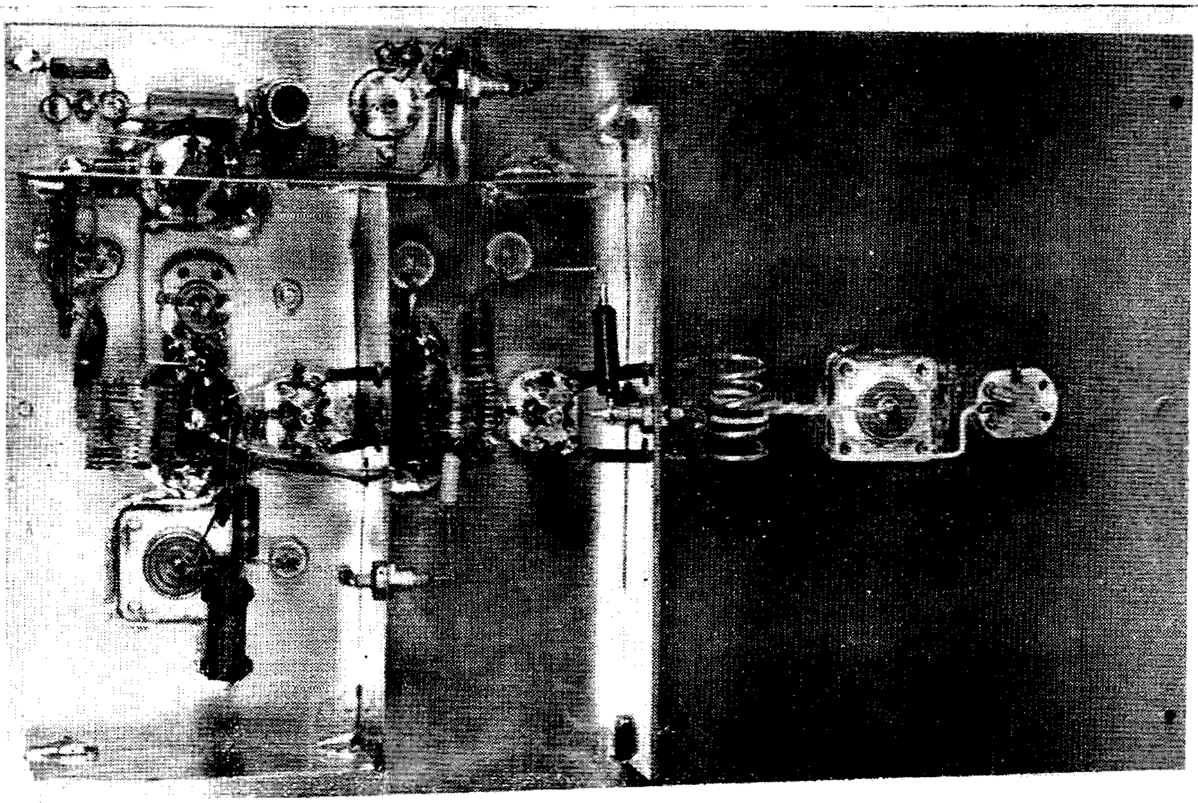
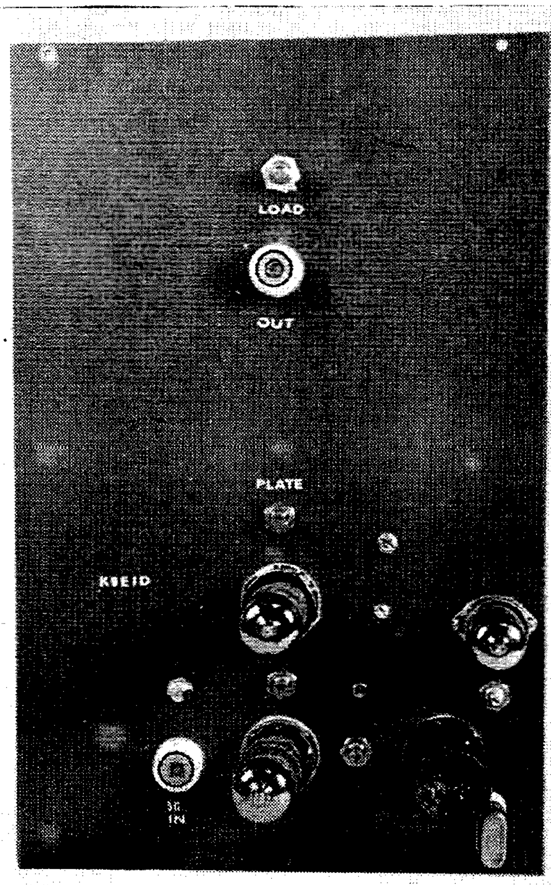


Fig. 1. Schematic of the six to two meter SSB mixer. B & W 3002 is two inches (5 cm) of ½ inch (8 mm) 8 turns per inch number 18 wire. It's the same as PIC 1728 and Air-Dux 408T. B & W 3011 has a diameter of ¾ inch (2 cm) and is 16 turns per inch (6 per cm).



Here's the bottom of the six meter to two mixer. The copper clad chassis plate is 5 x 6 inches (125 mm x 15 cm).



Top of the mixer. Tubes, clockwise from bottom center, are: OA2, 6EA8, 6360 and 6360.

turn between windings. This makes a neat, easy-to-mount assembly.

This particular unit was built on a chassis which was designed so that a final amplifier could be added later. The room available will accomodate a 5894, 829B, etc. The chassis could be made smaller if desired.

The power supply shown uses a power transformer from a junked TV set. It works well and is easy on that ole pocketbook! The bias circuit is a clever system since it needs no additional transformer. The switch in this supply can be on the antenna relay and allow the mixer to be cut off during the receiving cycle. Just remember that it should be open on receive and closed on transmit.

The voltages shown are operational voltages during transmit with S1 closed. These voltages will vary somewhat with different transformers in the power supply. The power supply is built on a separate chassis to minimize heat in the mixer unit.

This unit performs very well with six meter SSB transceivers. It is a very easy method of putting an SSB signal on two meters and it could also be used to put any six meter AM signal on two.

Have fun building and operating this fine unit. . . . K9EID

Silas Smith WA8CHD
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Flint, Michigan

A Slotted Line for 1250 mc

Here's an easy-to-build instrument for measuring frequency, VSWR and impedance.

The SWR bridge is a very useful—and sometimes badly neglected—tool. Especially on 1250 mc with only two or three watts of power, you should measure your SWR and do something about it if necessary. I recently joined the 23 cm boys, though I have only worked 1234 mc so far. My first attempt to communicate with W8VKQ on the other end failed but after two evenings of diligent work with a meagre amount of test equipment we made contact. It would have been a lot easier with test equipment good in the 1250 mc range since most hams are not equipped to measure frequency and adjust their rigs at these frequencies.

After that experience, I made the slotted line indicator described in this article. The cost is next to nothing and it's easy to build, but it does a good job. The unit is built around a one inch thin well copper tube 10¼" long (**Fig. 1**). This tube has a ⅛" slot cut lengthwise for 7½", about ¾ wavelength at 1250 mc. This is long enough to get a fair sampling of the standing wave or null points.

Three other pieces of 1" copper pipe are needed. Two are 5/16" long and one is 1⅝" long. The two 5/16" pieces each have ¼" cut out and are reshaped to fit inside the 1" tube. These two pieces were each soldered to 1/16" plates as in the detail in **Fig. 1**. This process makes two cup-like structures which should fit within the end of the 1" pipe. Drill nine holes in each cup: four holes for attaching the cup to the slotted line, four to fit the BNC connector mounting plate and one ⅜" hole to pass the main body of the connector. File two notches for the connector ears. You can fasten the cups to the slotted tube with small sheet metal screws, threaded holes or nuts soldered to the back of the holes.

The 1" x 1⅝" piece of pipe is for the probe carriage. It is cut lengthwise on one side, slipped over the 1" tube, centered, and a ⅛" hole drilled through it over the slot in the 1" tube.

The probe is built from ⅜" and ⅛" brass tubing from your hobby shop. At the probe end is an insulator from a coax fitting and on the

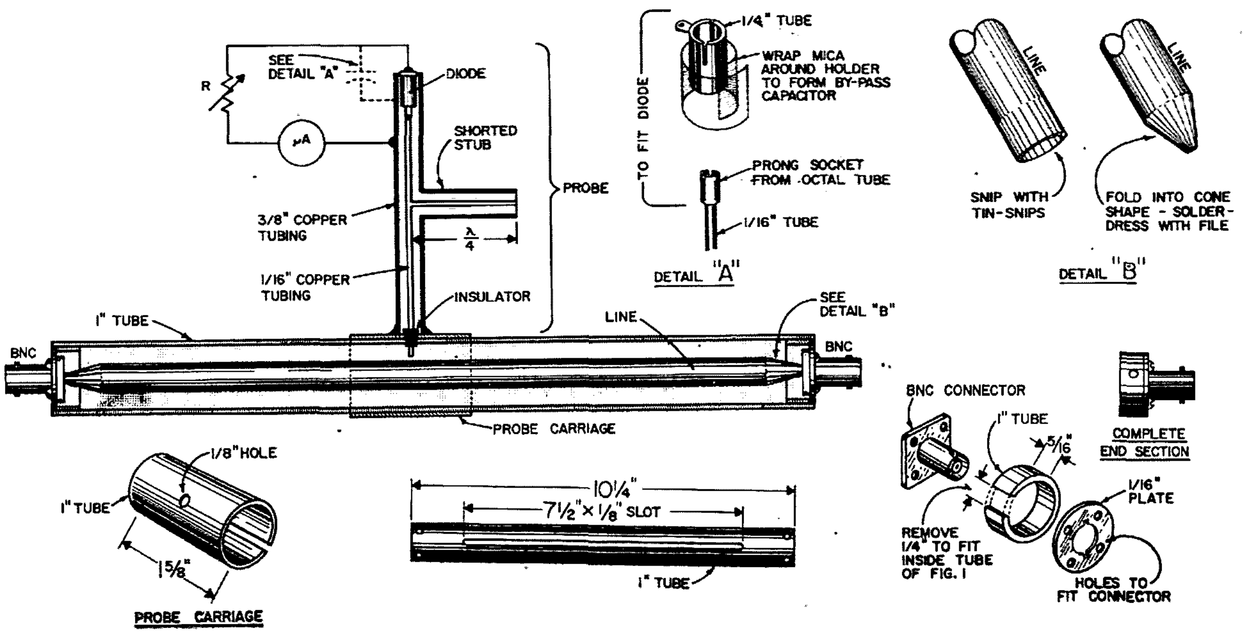


Fig. 1. The slotted coaxial line and probe for 1215 to 1300 mc described in this article.

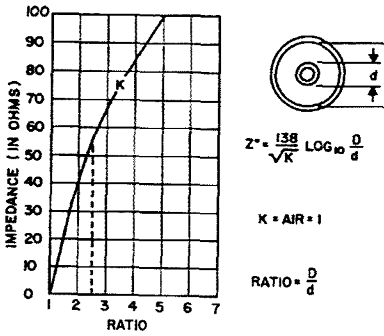


Fig. 2. Ratio of outer tube to inner line for various impedances.

other end is a jack made from an octal tube socket. A small piece of ¼" brass tubing is used to make the diode socket (see detail A). A piece of 22 gauge wire is inserted in the probe end of the 1/16" tubing and soldered. A 1N21 diode works very well.

Use **Fig. 2** to choose the proper size for the line in the center. Each end of this line should be tapered and soldered to the coax fitting as in detail B. The center conductor should be 7/16" for 50 ohms or 5/16" for 73 ohms.

The meter used should have a range that permits a full scale reading and should be calibrated with some scale.

Uses: Measuring frequency

Frequency can be measured with the slotted line in two ways: the distance between null points at one half wavelength ($\lambda/2$) or the distance between peaks. See **Fig. 3**. Measuring between the nulls is preferable since the peaks are very broad. If your line is flat, the peaks and nulls may be very small, so you may have to induce a mismatch in the line. Likewise, you may have to induce a mismatch to get the two nulls to fall within the 7½" of the line. The easiest way to induce a mismatch is a short in the line.

Measure the distance between the nulls carefully with a centimeter rule. Twice this distance divided into 30,000 will give you your frequency in megacycles. It would be a good idea to check this against a standard or at least avoid operating too close to the edge of the band.

Measuring VSWR

Measuring voltage standing wave ratio (VSWR) with the slotted line is easy, too. We are looking for a ratio of E_{min}, the minimum voltage on the line, and E_{max}. The ratio:

$$\frac{E_{max}}{E_{min}} = \text{VSWR}$$

However, there is a slight complication of vectors in E_{max} and E_{min}, so that to find them, you must first determine the highest voltage read on the meter, E_1 and the lowest voltage read on the meter, E_2 with the same setting of the shunt resistor, as the probe carriage is slid along the line. Now, $E_{max} = E_1 + E_2$ and $E_{min} = E_1 - E_2$ so that

$$\text{VSWR} = \frac{E_1 + E_2}{E_1 - E_2}$$

An even simpler method is to set the meter to full scale (100) at the highest reading, and reading the VSWR directly from **Fig. 5.**

Impedance measurements

It's a little harder to measure impedance, but even it's not bad if you do it step by step. First, consider the high impedance on your line when your antenna is open or shorted. Perhaps you don't think of it as a change in impedance. This is what we are looking for. Remember that there is a definite relationship between impedance and frequency. **Fig. 6** shows the voltage relationship between a short and open. On a short set the probe for a null point, usually the first null from load end of the slotted line. This will be our reference point. You will note that when the load point is open there is a shift of 90° or a quarter wavelength either side of the reference point. This adds up to one half wavelength. Any impedance between infinity and zero ohms will lie somewhere along the half wavelength of the line. It will be noted that an open is equidistant from the reference point toward the generator and toward the load, however the line has moved toward the load (capacitive reactance). To measure this reactance, we replace the load that we measure with a short. We set our probe to the first minimum reading from the load end of the slotted line. Mark this spot with a scribe. This is our reference point. Now we remove the short and add our load under measurement. It will be noted that the voltage has moved upward. Move the probe toward the load. If the volt-

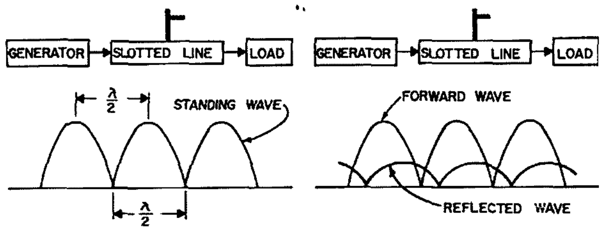
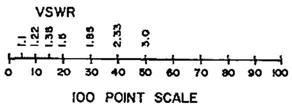


Fig. 3, Left. Measuring frequency. Fig. 4, Right. Measuring VSWR.



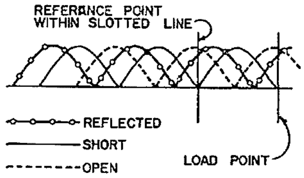


Fig. 5, Left. VSWR scale. Fig. 6, Right. Impedance measurements.

age goes down, you are heading in the right direction. If the voltage starts to go up change direction toward the generator. Move the probe as above to the new null point and note the direction that the probe has been moved.

Here's a step-by-step example. First, you'll need the frequency and wavelength, VSWR, direction of probe, distance between reference point and new null, and impedance of the slotted line.

Let's say as we measured the frequency, the distance between the null points was 12 cm. This is half the wavelength, so the wavelength is 24 cm. The frequency is 30000/24 or 1250 mc.

Let's say we read 80 as a maximum and 20 as a minimum on a point scale in measuring the VSWR:

$E_{max} = E_1 + E_2 = 80 + 20 = 100$
$E_{min} = E_1 - E_2 = 60$

$$VSWR = \frac{100}{60} = 1.66$$

Or set E_1 to 100 by adjustment of R, then E_2 would read 25 on the meter, a VSWR of 1.66 by **Fig. 5**.

As in **Fig. 6**, the probe was moved toward the load.

Let's assume the distance from the reference point to the new null was 2 cm. What part of a wavelength is 2 cm? Wavelength is 24 cm, so 2/24 = .083 wavelengths.

This is a movement of .083 wavelengths toward the load.

The slotted line used has an impedance of 50 ohms.

We are now ready to plot this information on the Smith chart (**Fig. 7**, better get out your magnifying glass).

Draw the VSWR circle at the prime center with a radius of 1.6.

Draw a line from .083 wavelength toward the load from the prime center.

At the intersection of the circle and line, follow the constant resistance circle to .74 and the capacitive reactance circle to .31. Our load impedance is then:

$Z_L = Z_0 \ (.74 - .31j)$
$Z_L = 50 \ (.74 - .31j)$
$Z_L = 37 - 15.5j$

Well, there are some of the things your slotted coax line can do besides telling you that you're on the air. A commercial version would cost $750. I guarantee that you'll get your dollar's worth out of this one as it costs less than $1 to build. I hope that it helps you get on 1250 mc.

. . . WA8CHD

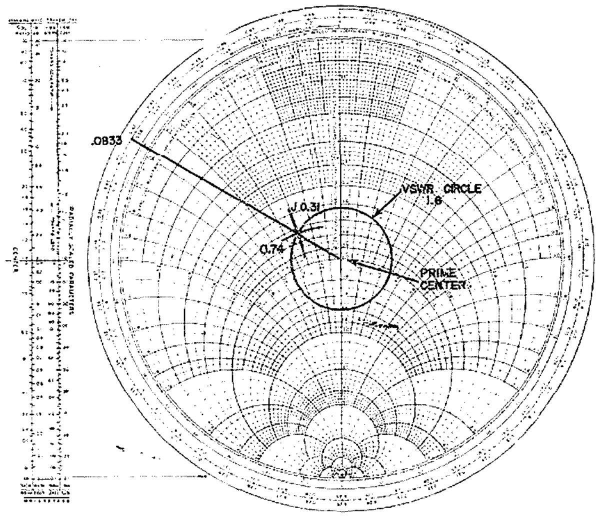


Fig. 7. Smith chart for determining impedance.

A Short Look at Current Propagation

Dear Paul:

Your recent letter mentions that some newcomers would like to know more about our propagation charts and you also ask for a preview on conditions for 1966 and the next few years. I will answer both questions in the following two part discussion dealing with the propagation charts first.

The basic data for the propagation charts comes from numerous ionospheric sounding stations scattered throughout the world. These sounding stations are managed by various governments, universities, and other research units. Our own Bureau of Standards plays a considerable part in the program.

Most of these stations measure the highest frequency that the ionosphere will return from a point directly overhead. They call this the "critical frequency" at "zero distance." The measurements are made on a 24 hour per day basis and have been in progress for many years. With this basic information, which incidentally also measures the height of the ionosphere, it is possible to construct a world-wide map of ionospheric "critical frequencies" versus time of day, month of year, and year of the sunspot cycle. By graphical techniques we convert the "zero distance" frequency to an "any distance" frequency. I might mention here that it is a pretty tedious job.

Sunlight and darkness control the critical frequency. It is "usually" highest around noon and lowest just before sunrise at any given point over the earth's surface.

When making frequency predictions we must first determine those points over the earth's surface where the radio signal makes its first and last contact with the ionosphere for any given circuit. These points in space are known as "control points." On a circuit 3600 to 4000 km long there is one control point for operation on the F^2 layer of the ionosphere. Also only one for shorter circuits. Circuits longer than 4000 km operate on two control points—these are the DX circuits and the control points are about 2000 km from each end of the circuit. A really long haul DX signal will be reflected by the ionosphere several times, performing a series of hops over the earth's surface. When the signal contacts a control point it makes up its mind then and there if it is going to go any further or not. If the frequency is too high for the control point, the signal will pass through the ionosphere and be lost in space. If it is too low it will be absorbed.

The control point demanding the *lowest frequency* in the chain of hops is the boss. Frequency propagation charts are constructed with this in mind. The signal will usually be best when there is only a moderate difference between the two control point frequencies. When one control point demands 8 mc and

John H. Nelson is a well known HF Propagation Analyst for RCA Communications. Among his articles are "Sunspots and Radio Weather" in the June 1948 RCA Review and "Observed Diurnal Variations in Frequencies and Signal Qualities" in the December 1954 RCA Review. He writes the monthly propagation column in 73.

the other demands 33 mc the circuit will be poor. This is because the amateur has to use 7 mc and as his signal approaches the 33 mc area it becomes absorbed by sunlight.

This latter situation prevails at *certain times* of the day on such DX circuits as Eastern U.S.A. to Japan, Philippines, India and Australia. It also prevails on Western U.S.A. circuits to Europe, India and Africa. Another factor that might be mentioned is that the longer the circuit (in the northern hemisphere), the closer the signal will pass to the North Pole. Here the signal must pass through the auroral zone. This is bad because of severe absorption.

The hours of the day during which the signal will suffer significant absorption is indicated on my charts with a symbol.

Now for the second part of your question. The new sunspot cycle began to show a significant increase in sunspot numbers in September 1965 but it is increasing quite slowly. The low part of this cycle has lasted much longer than the low of 1954 and 1955 and is increasing more slowly. This indicates a strong probability that the forthcoming cycle will be of only moderate intensity.

One of the strange features of the present sunspot situation and the current frequency behavior pattern is that in spite of the slow increase in sunspot numbers there has been a disproportionate rise in useful frequencies during day time hours. However, no important change has occurred in night time frequencies when compared to the past two winters. This is quite puzzling.

So far, the present sunspot cycle has produced only one really large sunspot. This spot crossed the sun during the first ten days of September. It did not do much damage to radio signals but did produce numerous solar flares. Today, December 5th, 1965, using a six inch telescope, I can find only one tiny spot on the sun.

The number of sunspots will increase throughout 1966, 67, 68 bringing with them an increase in critical frequencies. The ultra violet light radiated by sunspots creates a more dense ionosphere which, of course, has a higher critical frequency. DX fans will benefit by this but it is doubtful if the phenomenal results of the last sunspot cycle will be duplicated.

DX conditions will generally improve throughout this forthcoming rise, but it might be well to apprise the new-comers that they are going to come upon some strange situations during the next few years.

Quite a number of the fast growing sunspots

"I dont suppose you know anything about what happened to my coil stock."

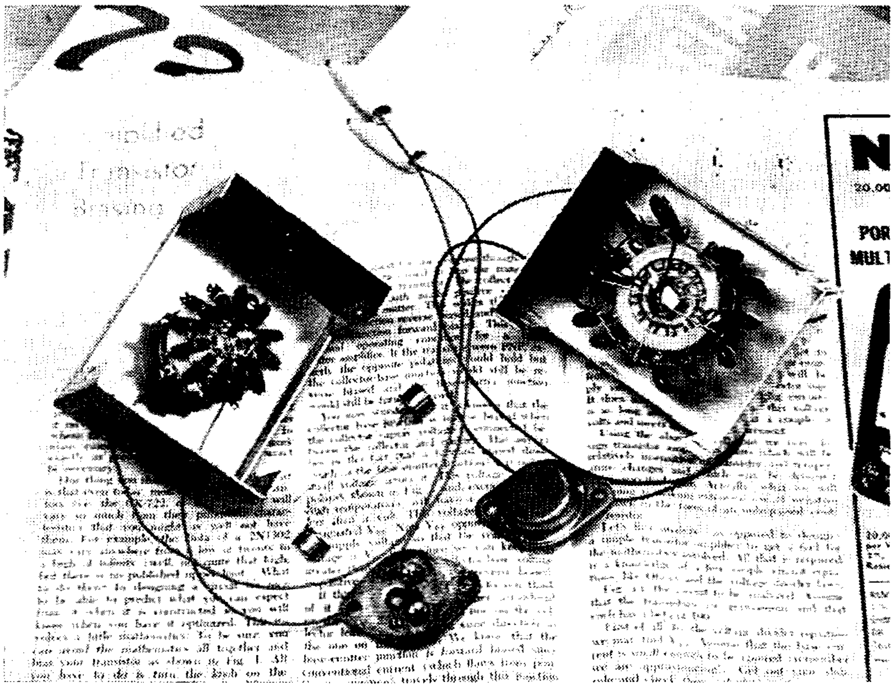
during the rising portion of the sunspot cycle develop great solar flares. The flares produce such intense ultra-violet radiation that our atmosphere becomes so strongly ionized that it absorbs all HF signals, resulting in a complete absorption blackout. This happens only during daylight and usually lasts around half an hour. To experience one of these blackouts is dramatic to say the least. Signals change from perfect to absolutely nothing in two or three seconds.

There will be cases of night time blackouts during which DX signals will be useless for two or three consecutive nights whilst during daylight hours the signals will be very good from sunrise to sunset. This will not happen very often however. In general we are going to find that DX signals will be much better than they have been for the past three years. The tendency will be towards more severe disturbances but of short duration.

I have studied sunspots and their effects on HF radio for 20 years and have observed thousands of spots through a six inch telescope. It is a very complex research program. The references in this letter regarding ultraviolet are not based on my own work. The astronomers tell us that it is UV that produces the ionospheric effects that I mention, the theory being that UV has strong ionizing capabilities.

With best regards to yourself and Wayne, I'll close now, with the sincere wish for an abundance of UV for your DX fans.

. . . John Nelson



Here's a new look at an excellent old idea. No experimenter should have to work without Diddleboxes.

James Ashe W2DXH
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Freeville, N.Y. 13068

Diddleboxes

Sometimes my circuits don't work quite right and I have to try fitting in different components to remedy the situation. Pots and variable capacitors will do, but fixed components seem to be better suited for these tests. For instance, it's quite easy to burn up a two watt pot because at ten percent of rotation its power rating is down by ninety percent! And the thing always has to be measured to complete the test.

Decade substitution boxes go right back to ancient history. I've seen them in very old catalogs. They're wonderful things. You can jump from one ohm to one megohm at the flick of a switch, and it's the easiest thing to tack on or trim off a few ohms by turning one or two knobs.

But I reasoned that, since I'm going to choose the nearest resistor, why not start out that way? There is no need to play ohmic arpeggios on a megohm scale, the circuit will never notice my virtuosity. Another point is that a simple rotary switch with twelve resistors will have far less parasitic inductance and capacitance than the extensive system in a decade box. Sounds like a good thing, and that is the way it has worked out.

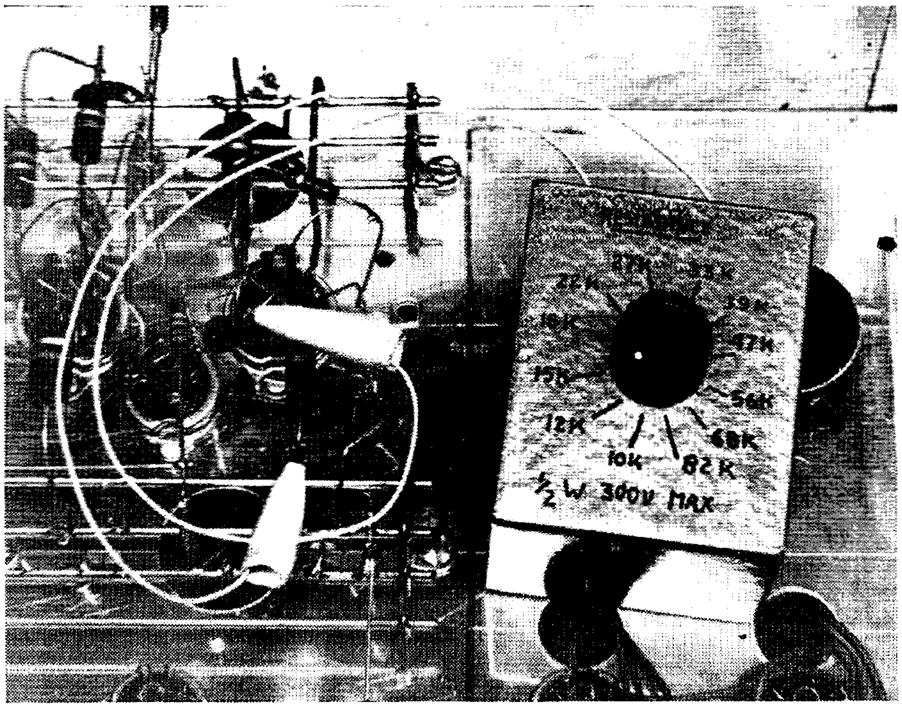
W2DXH is a self-employed technical writer interested in design and construction, moonbounce and space communications. A number of his articles have recently appeared in 73 and more are upcoming.

There was some difficulty in finding good 12-position switches. But I found two suppliers who could provide satisfactory single pole 12-position switches: CTS and Mallory. The CTS switches come in a very convenient build-it-yourself style and I have found them useful for many applications besides diddle boxes. It might be nice someday to build from 16-pole switches, because then each decade could overlap the adjacent ones. This has not proved to be much of a handicap.

The three photographs show nearly the entire story of building diddleboxes. Note that the wires are kept as short as possible, and that the capacitors have a shorted ring in common. This reduces parasitic inductance and capacitance.

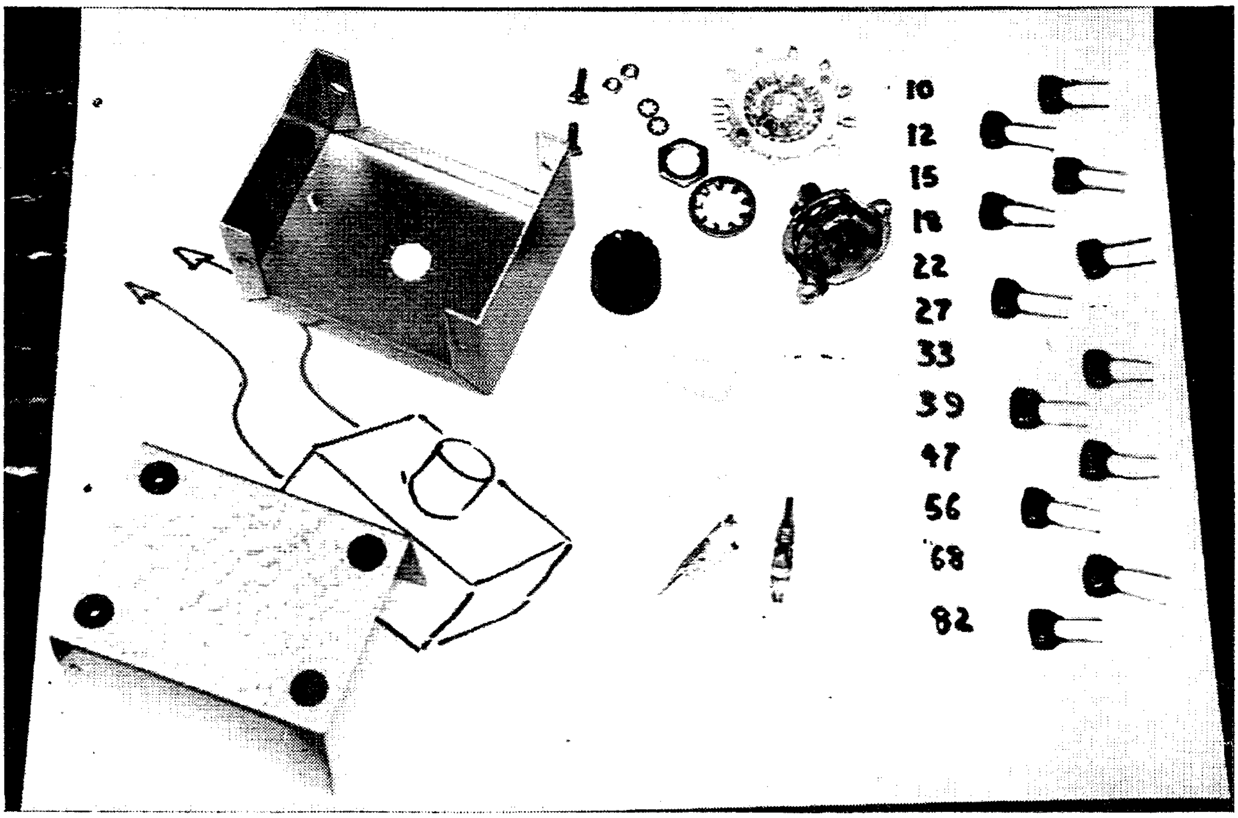
The leads go out through quarter inch grommets. I have been most satisfied with

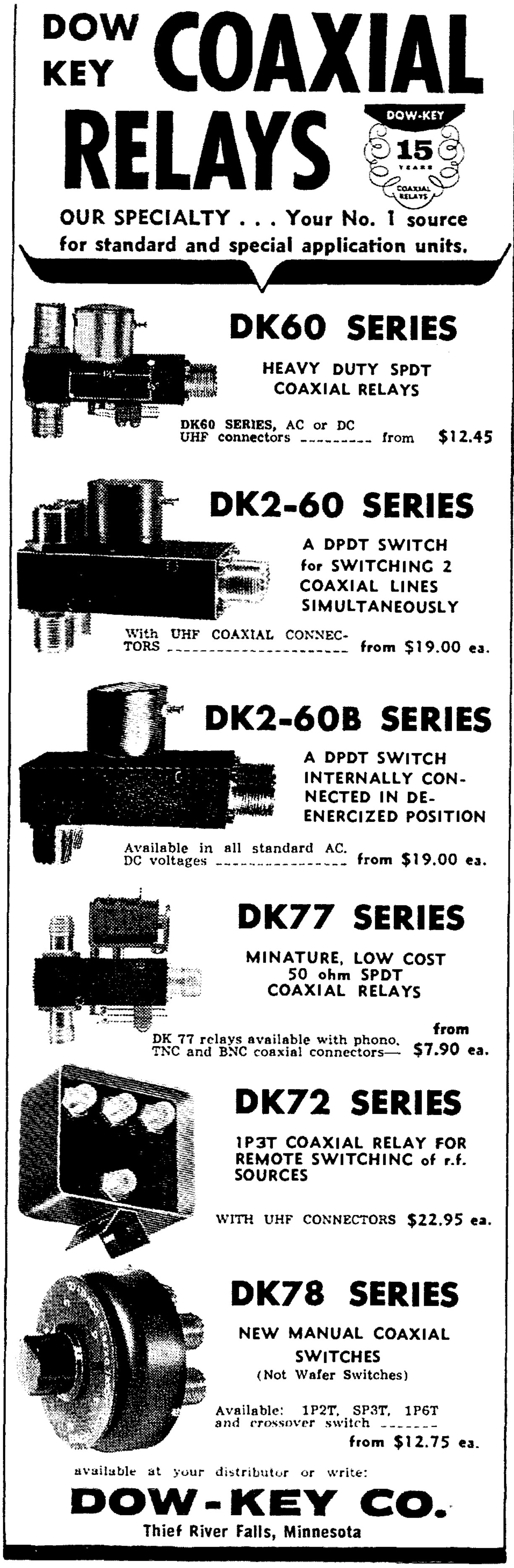
At the left are two Diddleboxes opened up to show their construction. To the right is the Diddlebox covering 10 k to 82 k in use on a breadboarded circuit. At the bottom of the page are all the parts for a Diddlebox except the wire for the leads.



Mueller #34 Microgator clips, with a tiny plastic cover. I trim the last eighth inch off the cover so the jaws are clear. A tentative idea of putting phone tip or banana jacks in the boxes for test lead attachment has never been carried out.

I have been very successful in marking painted or unpainted panels with India ink. The secret is to scrub thoroughly with strong detergent and a cotton rag to get off all the grease, rinse without touching, and let dry in a warm place. The clean surface takes ink as well as paper does, although it has a very different feel under the pen. Untouched, freshly enameled surfaces do not seem to require this treatment. After lettering, some nail polish or a coat of good, clear enamel makes things permanent.





My boxes contain 10% components, selected for on-the-nose accuracy by a good impedance bridge. They're all well within 1%. If you don't have a bridge, 5% and 1% components are available from surplus sources. It's worth some time and expense making sure they're right, because you will be using them for years. A key point is don't roast them. Use a transistor heat sink if you must, and work rapidly. You'll come out way ahead in the long run.

There are two basic kinds of switches. Shorting switches make before break, non-shorting switches make after break. Each has its place in certain types of circuits. For instance, shorting switches are preferred for selecting meter shunts, because the shunting resistance will drop way down between ranges. If you used a nonshorting switch for this job, you might find yourself pinning the needle between positions.

From a diddlebox testing viewpoint, circuits fall into two general classes: those which give problems and those which don't. The ones which don't are low-frequency and pulse circuits in general. They don't care if one or two components have remarkably long leads during testing. There is little danger of feedback throwing these circuits into oscillation. The substitution test procedure is peaceful and easy. This is the way I like it!

High frequency and short risetime circuits are harder to work with. I believe there is no substitute for a good understanding of how the circuit works. Then you can tell what it's likely to do when you put the long leads in. Two suggestions that have worked for me are: put something in series with the diddlebox, such as an RF choke or a small resistor, or revise the circuit so it is less affected by the long leads.

Over the past few years I've accumulated a number of diddleboxes. Not all of them are the single-decade type I've described here. One has a supply of bypass capacitors. Another quite large box holds some electrolytics. Most of the resistor and some of the capacitor boxes are in pairs. Certain symmetrical circuits, such as bistables, require this.

My experience with diddleboxes has been very favorable. I haven't lost one yet! I think this is because of a certain policy of working out what ought to happen before doing a test. I try to set it all up so only a few seconds are required to get the answer.

At three to five dollars per box, I believe a set is as good and as basic an investment as a VTVM.

. . . W2DXH

Henry Cross W1OOP
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Needham, Mass. 02192

Modernizing a 432 mc Converter

Bring your old converter using Philco MADT's up to date at low cost.

Back in the old days (December, 1960) when Philco was in the transistor business and not making Fords, Philco Application Lab Report 684, titled "R F Amplifier and Frequency Multiplier Performance of the 2N1742 VHF MADT Transistor at 420 Megacycles" was written by J. Specialny, Jr. A later version of that was reprinted in an early issue of 73 (with the circuit diagram in the following issue), and many of these converters are in use or on shelves in ham stations.

One reason for their being on shelves is that the 2N1742 had a relatively low gain, and a noise figure of 9 or 10 db at 432 mc. The T 2028 was an improvement, and the 2N2398 better still, but they are not on par with the more modern pnp mesa transistors available from TI and Motorola. The TI-XMO5 and TI-XMO6 are particularly good, and the price is right. If you buy ten dollars worth, the chances are you'll get a dozen which are capable of under 4 db noise figure at 432 mc, and the rest will be pretty good, too.

Another reason for shelf service is that it is

W1OOP is well known for his ham activities (building modern equipment that works, 432 mc, VHF contests) and writing. Few ham authors are more competent, clear or clever, and I cry when I see his articles in QST. He's a design engineer at Microwave Associates and he claims that he and his six hams work on test equipment. Test equipment. Hank studied Greek (among other things) at the Roxbury Latin School before he got his class A license in 1944, which probably explains something.

pretty easy to kill a VHF transistor. If it didn't short out, it still might deteriorate in perfomance due to an overdose of rf. I think techniques in coax switching have improved in the last few years among hams, but there are still shacks where the receiver takes a beating every time the transmitter is put on. I have shown a silicon diode limiter on the input of the modernized converter for this reason. If the right diode is used, there is no loss in performance from this. Many of the early varactors are suitable. The easiest way to spot them is to measure the breakdown voltage at about 1 ma. Diodes having a breakdown below 10 v which are sold as microwave varactors are probably suitable, but those having breakdown voltages higher are likely to be more lossy at zero bias. In any event, a serious VHF ham should be able to check his receiver performance or noise figure, and detect either gradual deterioration or catastrophe. The same kind of check will show whether hooking the diode up makes things appreciably worse. In my case, no difference could be measured.

The first RF stage was changed from grounded-base to grounded emitter. At UHF the grounded-base connection is regenerative, and with the higher gain of the newer transistors, stability is a problem. I set the first stage up grounded-emitter because it is more stable (even without neutralization) and because there is a slightly lower noise figure, in theory. The second stage was left unchanged (I used a TI-400 for that, which is not as

1. 73, March and April 1961.

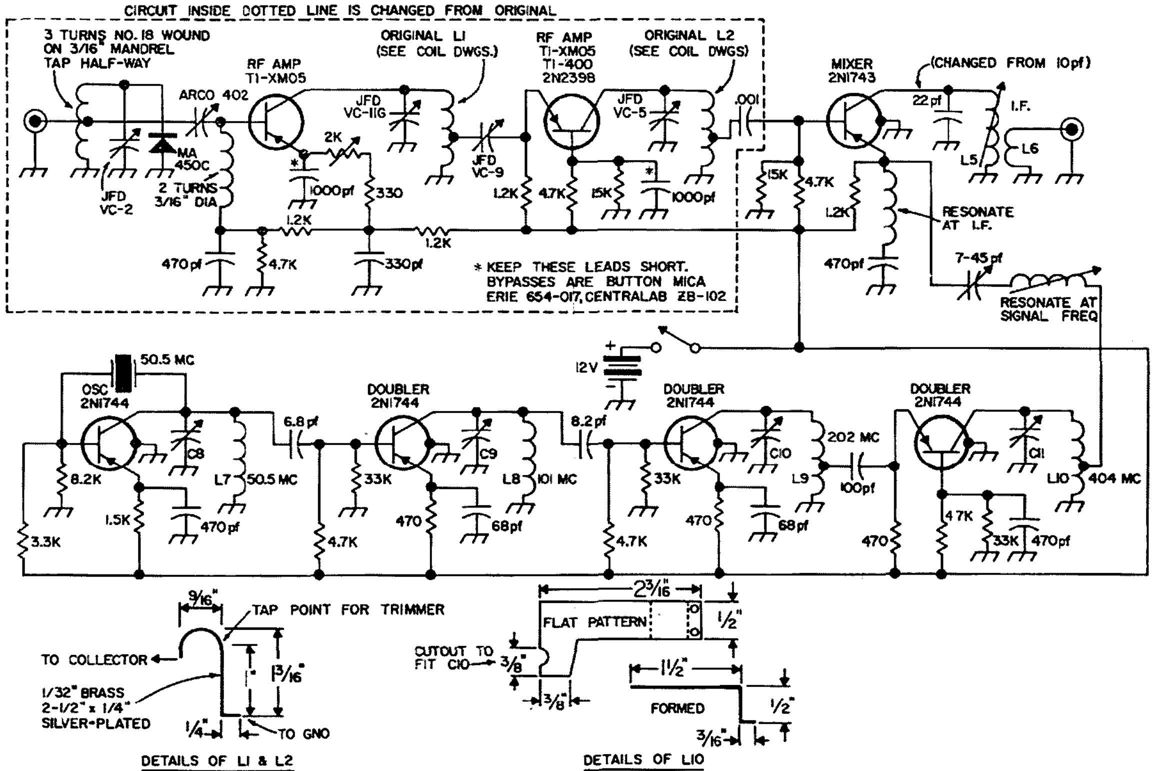
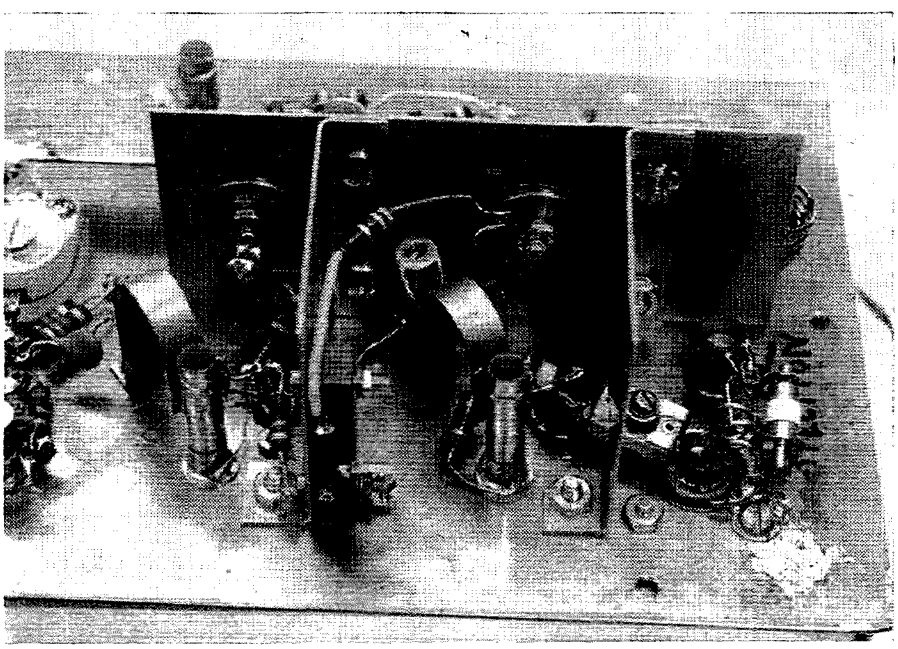


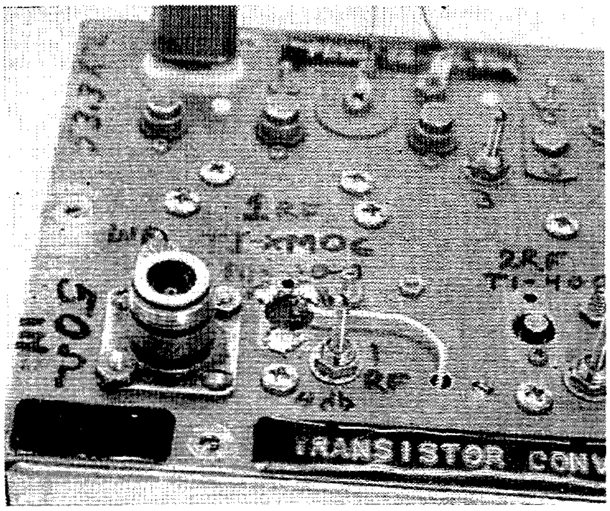
Fig. 1. 432 mc converter. This is a modern version of the 432 mc converter described in the March and April 1961 73's. While the only changes are in the rf amplifiers, the rest of the circuit is included so that you can make the converter without referring to those early issues.

"hot" as the XMO6 that I used in the first RF). When a TI-400 was also in the first RF the noise figure was a little bit worse than with the XMO6. The main point is to keep the grounded electrode lead *short*. *Don't* use a socket. ANY length is undesirable. The first stage emitter was run to the tab of a mica button feedthrough which was soldered into a hole in the chassis, with about a sixteenth of an inch of free lead. The button bypass should be about a thousand pf.

When I try to use a lower capacitance bypass the stage goes into some sort of HF parasitic oscillation. The emitter return ran outside the chassis a ways, then came back in to go to the pot in the bias circuit. It seems that



Philco converter as modified. Input is at right with protective diode across the first coil. The transistor is just visible to the left of the first shield. It's a small plastic half sphere.



Top view of the front end of the converter showing the emitter return from the first rf amplifier.

for any transistor type there is a best current to run at, and it may vary by two to one among transistors of a given type, thus the adjustment. Turn pot for best signal-to-noise ratio; the input tuning and the Arco trimmer are also adjusted for best NF or best s/n on a weak signal; grab the aligning tool and have a ball.

The W3IIIX converter shown in the pictures belongs to W1YWQ. It is set up for 5.6 mc *if* and the noise figure measures about 4 db. The image ratio is 21 db, so there is under one percent image noise power contribution, not enough to matter. I would advise 14 mc *if* for easy tuneup in 432 converters, but this one works very well.

The diode I used was an MA-450C. These are no longer made. The modern type would probably be an MA4321B (wire lead) but if you tried to buy only one you might decide that the money would be just as well spent on a good coax relay. I use two in cascade in the receiver line, and get less signal with the relays in the transmit position than with the patch cable disconnected and the end connector exposed.

. . . W1OOP

Coil and Parts Data

L1 and L2 are on diagram.
L3, the coil marked "resonate at if" in the emitter of the mixer, is 14 turns #28 on ¼" iron slug form.
L4, marked "resonate at signal frequency" is about one turn #22 3/16" diameter.
L5, 18 turns #28 closewound on ⅜" form with iron slug.
L6, 3 turn link on L5.
L7, 10 turns #20 tinned copper ½" ID, ⅝" long.
L8, 3 turns #20 tinned copper ½" ID.
L9, 5 turns #18 tinned copper ¼" ID, ½" long. Tap at 1¼" turns from ground.
L10 is on diagram.
C8 and C9 are 1-18 pf piston trimmers.
C10 and C11 are .5-8 pf piston trimmers.

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Power Control Through Magnetic Beaming

In a recent article in the Cathode Press, members of the staff of Machlett Laboratories have discussed a magnetically beamed, super power tube. Briefly, the somewhat random and irregular movements of the electrons in their passage from cathode to anode have been regimented—electronically speaking—and with their passage thru the grid barrier thus expedited, the resultant has two very beneficial factors: lower driving power than usual for triodes, and higher plate efficiency than would otherwise be expected. The magnetic "assistance" to the electron flow also causes more of the cathode emission to migrate to the plate; and those electrons so diverted will result in less heating of the control grid structure. The foregoing is a somewhat brief and unguarded analysis of the original story.

Always eager to apply new developments to amateur radio, I began experimentation with a receiving type tube and a permanent magnet. The vacuum tube was a type 6CL6, connected as a high-mu triode; the magnet utilized was a Lafayette "power magnet" their stock number 14R3302. The circuit utilized was as shown in **Fig. 1.** For some inexplicable reason, our magnetic "beaming" did not seem to speed up the electron flow; but it was possible to decrease the flow of electrons by tremendous ratios. The failure to obtain the expected positive results might lie in the fact that most receiving tubes are made with magnetic materials in their anode structures; or it might possibly be that the grids in the tube under test were quite closely spaced. Whereas the grid wires in the power tube under original discussion were relatively wide apart in their spacing.

In our first experimental setup, the magnet sat atop the tube, with the glass tip of the 6CL6 projecting thru a hole in the central top of the magnet. By simply rotating the magnet, our previous "normal" plate current of 10 milliamperes was reduced to a low current of 30 micro-amperes, for a ratio of 330 to 1. See **Fig. 2** sketch.

Our next attempt at controlling the magnetic flux was to insert the 6CL6 tube inside the curved part of the magnet. The soft iron bar, or "keeper" was kept separated 3/16" from the pole pieces of the magnet proper by spacing with Teflon blocks. We began this experiment with a "norm" of 9 ma of plate current—i.e., with no magnet. Through rotating the tube and by sliding it back and forth inside of the magnetic field, it was possible to reduce plate current to 2 micro-amperes, using "magnetic cut-off." This gave us a control ratio of 4500:1. See **Fig. 2.**

Somehow we kept obtaining the impression that we were not quite "on the ball" in applying our theories, so the Teflon spacer blocks (thru which the magnetic flux had to pass to

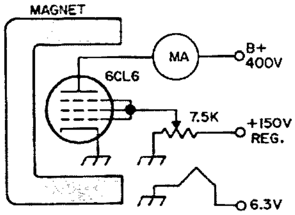

Fig. 1. Circuit for magnetic control experiment.

circulate from pole pieces to the magnetic keeper) were increasd to 9/16 inch and while going through the same routine, the 9 ma normal current was decreased to approximately 1 micro-ampere, for a ratio of roughly 10,000 to one.

Still feeling somewhat frustrated, we hit upon the idea of leaving off the "keeper" and so the magnet was employed without any auxiliary agent, other than the vacuum tube under investigation. This setup resulted in the 9 to 10 ma "norm" of plate current being reduced to ½ micro-ampere. This would signify a control ratio of approximately 20,000 to 1. This was the result of careful placement of the tube within the magnetic field, but it was no "freak" for the experiment was readily reproducible.

While our original goal of increased sensitivity was not reached, it is felt that the method outlined does have promise for certain amateur applications. With a power ratio in the neighborhood of 43 decibels, it is evident that we do have quite a range of control here. Designing a suitable electro-magnet should not be too difficult a matter, and such circuitry could be used for on-off power control (keying?)—possibly for incremental power control. This suggests, possibly, some form of modulation. Lack of time at home, plus a heavy work schedule, has kept me from pursuing this idea any further at this time. Rather than let the idea die, it is being passed along to the fraternity for whatever modifications, applications, additions and results they might obtain. Good hunting!

. . . W2OLU

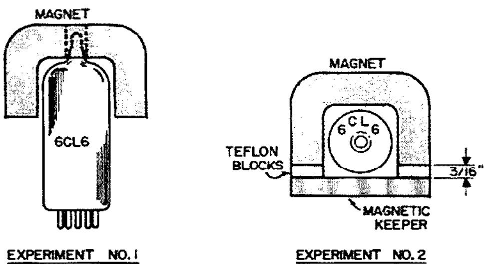

Fig. 2. Experiment 1 gave 10 ma "normal" flow and 30 μa at "magnetic cutoff," i.e., when magnetic flux cuts electron beam at 90 degrees.

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Vertical Antenna Band Changing Unit

In these days of the waning sunspots, increased attention is being directed toward efficient low angle vertical antennas for the 80 and 40 meter bands. One of the more popular antennas is the 40 to 45 foot radiator with an appropriate tuning network at the base to enable operation on 80, 40, and 20 meters. Such an antenna was very adequately described in the August '63 issue of 73.

While this type of antenna is convenient to use from the standpoint of three band operation in one antenna, it is very inconvenient to make the trek to the base of the antenna to change bands, particularly when the snow is knee deep. This is the situation which brought about this very simple and inexpensive remote bandchanging setup.

First consideration was given to motor driven switches, but they were ruled out due to their tendency to get stiff during very cold weather. This left relays as the only practical answer to dependable all weather operation.

Briefly the operation is as follows: When K1 and K2 are both de-energized the coax from the transmitter is connected to the 20 meter tap on the coil. When only K1 is energized, the coax is connected to the 80 meter tap and the antenna is also changed to the 80 meter tap on the coil. When both K1 and K2 are energized, the coax is connected to one side of the capacitor "C" and the antenna is connected to the other side of this capacitor.

Figs. 1 and 2 should be very self-explanatory but a few points should be kept in mind. First, low voltage DC relays should be used to minimize the possibility of voltage breakdown in the buried control cable. Only two wires are necessary as the relay coils are operated against ground. It will be necessary to tie one or two wires of the antenna ground system to the house ground to insure a good low resistance return for the relay coils. Two conductor #14 house wiring suitable for direct burial is excellent for this purpose, particularly on a long run where voltage drop might become a problem. The relay contacts should be capable of handling at least 5 amps.

The interconnections between relays, coil and antenna should be kept as short as possible. Also, an antenna current meter may be inserted at point "X".

The purpose of this article is only to describe a remote bandchange-over unit and should not be used to construct the whole antenna system itself. For this, the reader should refer to Brier's article on Vertical Antennas in the August 1963 issue of 73.

Good luck and may you keep your feet dry! . . . W7BWB

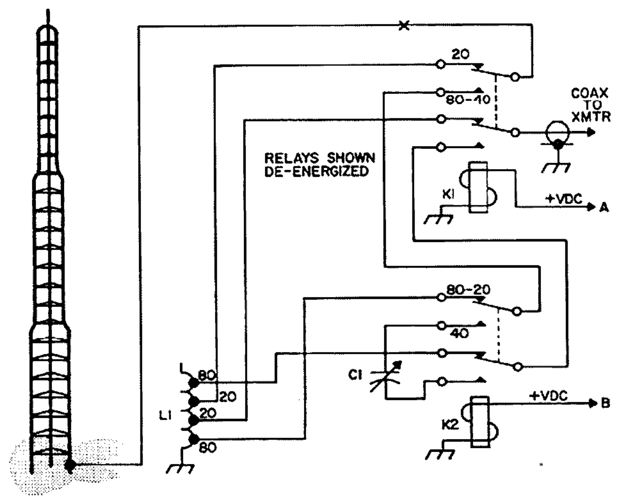

Fig. 1. Changeover unit diagram.

Parts List

K1, K2—Low voltage DC relays with hi-current contacts
T1—Suitable voltage for above relays; approx 1 amp
D1—100 piv 2 amp silicon diodes
SW1—2 pole 3 position rotary switch
C2—500 µf 50 volt Electrolytic

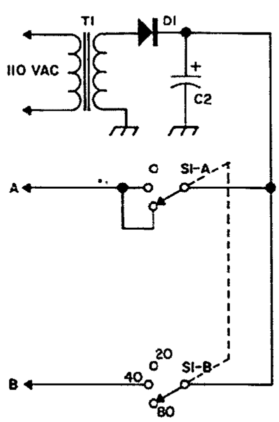

Fig. 2. Power supply and control.

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Choosing IF and Mixer Frequencies

When building receivers or converters, one of the most important steps is the choice of suitable *if* and mixer frequencies. Most amateurs follow the simple rule of thumb that the intermediate-frequency must be greater than 5% of the center frequency in an r-f stage. In amateur band receivers this difficulty is usually solved with a first *if* of around 1600 kc in a dual conversion arrangement.

However, when the desired signal and high-frequency oscillator are mixed to obtain an output at the intermediate-frequency, the mixing process inherently generates harmonics of the two incoming signals. Consequently, spurious signals occur at these harmonics and the various combinations of their sums and differences. If these spurious signals are not considered when selecting an *if* frequency, some may fall within the *if* passband where they cannot be filtered out. In many cases this will result in undesirable distortion of the *if* signal, or at the very least, annoying "birdies."

Many charts and graphs have been published which may be used for this purpose, but in most cases they are so complex they do not simplify the task. The information shown in **Figs. 1** and **2** is identical to that normally available, but it is arranged in a form that is easily used. With these graphs it becomes readily apparent when a particular mixer frequency will produce undesirable "birdies." Although these graphs include only those signals generated by the first six harmonics of the two mixing frequencies, harmonics higher than this are usually of such low magnitude that they cause no problems in amateur applications. Because of the different relationships in the mixing process, two graphs are required, one where the *if* is at the difference of the two incoming signals, the other at their sum.

The only information required to use these charts is the ratio of the lower frequency (F_s) to the higher frequency (F_h). This ratio indicates the entry point to the chart.

For example, assume that we are selecting an *if* frequency for a 6 meter converter. If we were to select an *if* of 30 mc, a 20 mc local oscillator would be required for the desired difference frequency output. Computing the ratio of F_s/F_h, $20/50 = 0.4$, we would look at this point on the difference frequency graph of **Fig. 1**. Here we find that there are two spurious signals that fall in the center of the *if* passband, $4F_s-F_h$ (80 mc–50 mc = 30 mc) and $3F_h-6F_s$ (150 mc–120 mc = 30 mc). Obviously this is a poor choice.

How about a tunable *if* from 7 to 11 mc? This would require a local oscillator of 43 mc; compute the ratio F_s/F_h at both ends of the band: $43/50 = 0.860$; and $43/54 = 0.796$. Looking at the chart we see that no spurious signals are present at these frequencies, but note the birdies that fall between these two limits at 0.8, 0.833 and 0.857. With an *if* that tunes from 7 to 11 mc to cover the 50 to 54 mc band, this indicates that birdies would appear at 53.75, 51.62, and 50.18.

Consider the ever-popular 14 to 18 mc tuner commonly used by amateurs with VHF converters. To tune the six meter band, a crystal controlled local oscillator at 36 mc will mix with signals in the 50 to 54 mc range and provide the required output. Let's compute the F_s/F_h ratios and see what kind of birdies we

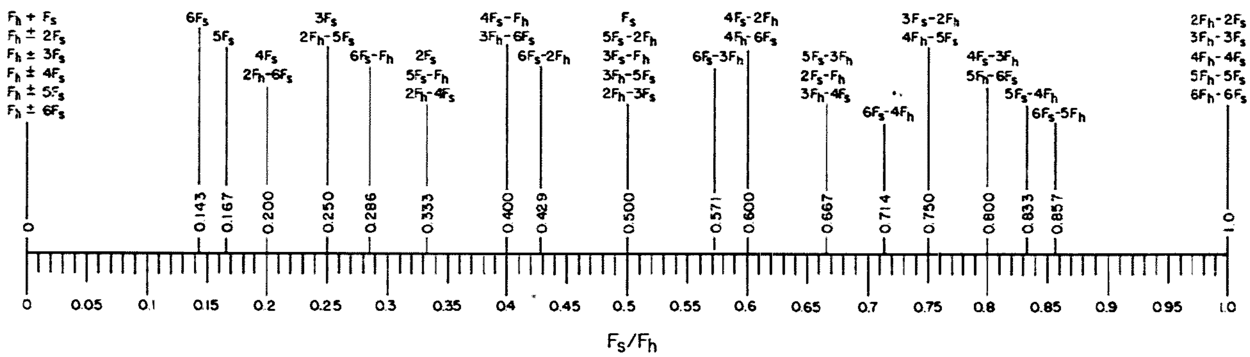

Fig. 1. Difference frequency output.

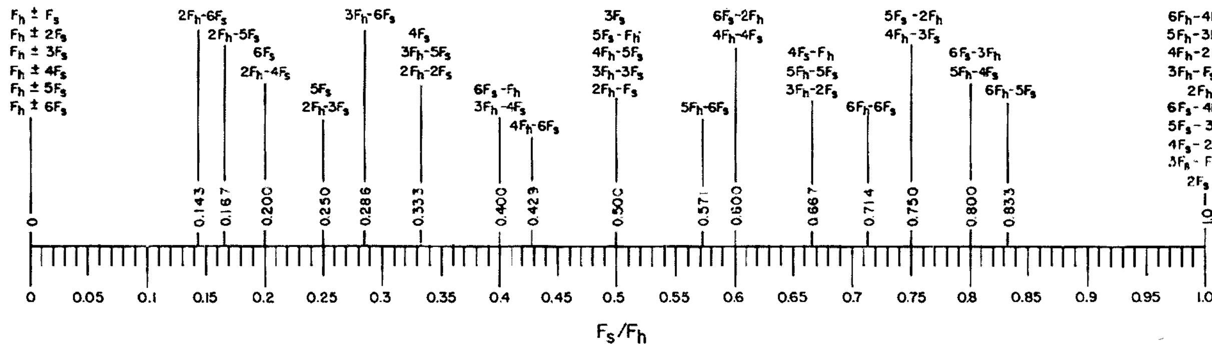

Fig. 2. Sum frequency output.

have; 36/50 = 0.720 and 36/54 = 0.667. Looking at the chart of **Fig. 1**, we can see that there are three prominent birdies coinciding with the ratio 0.667. Since in all probability we wouldn't be interested in operating at a band-edge anyway, these birdies are probably not significant. However, look at the 0.714 point on the graph; a big fat birdy corresponding to 50.4 on the dial!

To obtain an *if* tuning range large enough to cover the entire six meter band and yet avoid spurious signals it is necessary to locate an area between two birdies that is wide enough to cover the entire band. One way of doing this is to operate at the upper part of the graph between 0.857 and 1.0. We may rearrange the F_s/F_h ratio so that when we know the required ratio (greater than 0.857 in this case) we can find the required local oscillator frequency:

$$F_s = 0.857\ F_h$$

From our example in the 6 meter band,

$$F_s = 0.857 \times 54 \text{ mc} = 46.278 \text{ mc}$$

To prevent a birdy from appearing at 54 mc on the converter dial, the local oscillator frequency should be slightly higher than this minimum to ensure that the spurious response is well outside the *if* passband. Using a local oscillator of 47 mc and a tunable *if* from 3 to 7 mc would meet these requirements.

These examples have all assumed the use of a crystal controlled local oscillator, but in some cases a tunable oscillator may be desirable. As an example we might consider an *if* of 7 mc and a tunable local oscillator from 43 to 47 mc. Compute the F_s/F_h ratios at the ends of the band: 43/50 = 0.860 and 47/54 = 0.870. Note in these two equations that the local oscillator frequency (F_s) is different because it is tunable. Looking at the chart in **Fig. 1**, no birdies appear between 0.86 and 0.87 on the chart so this is a perfectly satisfactory choice. Going back for a moment, you will remember that a tunable *if* from 7 to 11 mc resulted in birdies; here we can see that a tunable oscillator and an *if* output of 7 mc does not. Obviously in some cases a tunable oscillator is a definite advantage (not withstanding the problem of oscillator stability).

These examples have assumed that the local oscillator is lower than the signal frequency, but a similar method is used when the local oscillator is higher. The only thing to remember is that the lower frequency is always divided by the higher frequency to obtain the necessary ratio. In some cases the use of a higher oscillator frequency will move the ratio to a point on the graph that is free of spurious signals. In commercial amateur band receivers this technique is sometimes used in the 3.5 to 4 mc band.

Choosing an intermediate-frequency where the desired bandwidth is not too great presents fewer difficulties than where a wide bandwidth is required. This is evident on 144 mc where the entire two meter band is a relatively small percentage of the operating frequency. In this case it becomes quite easy to sandwich the desired tuning range between the spurious signals on the graph. For instance, a tunable *if* from 27 to 31 mc (local oscillator at 115 mc) would be quite suitable for the two meter band because the F_s/F_h ratios would fall between the birdies at 0.75 and 0.8 on the graph and no spurious responses would fall within the tuning range of the converter.

The sum frequency graph of **Fig. 2** is used in exactly the same way as **Fig. 1** except that it is oriented toward those cases where a sum-frequency mixing process might be desirable. Usually this will occur when mixing a very-low-frequency signal up to some standard intermediate frequency.

These graphs have proved to be particularly useful when selecting a common intermediate-frequency for several different VHF converters or when choosing *if*'s for homebrew amateur band receivers. Without a graph of this type it becomes a hit or miss situation with a good probability of difficulties with unwanted spurious signals.

. . . WA6BSO

THE HUSTLER NEWS

T.M.

FROM "The home of the originals" ***Number 1 of a series***

This is the first article in a series dealing with hints and kinks in antenna installation to help amateurs obtain the very best in mobile or base-station antenna performance.

The elusive ground

Amateurs are relying more on the antenna manufacturer for information critical to his particular antenna installation. Today, many variables in radio system designs make this a difficult task. The New-Tronics people feel a well engineered product should be devoid of sundry outboard articles. Specifically, antennas without special coax lengths, base tuning or matching.

Contrary to popular belief, you *can* control base impedance and you *can* maintain a reasonable operation Q yet retain bandwidth and minimum SWR. Amateur mobile antennas require good ground plane systems. An auto body can't always be considered ground unless unitized electrically into a common ground. Often, fenders, hoods and trunk lid panels have been found completely insulated from the rest of the body due to paint. To complicate this, the body itself is often insulated from the frame. In some cases, bumpers and even engines are not grounded to the frame or body. The only sure-fire way to solve this elusive ground problem is to braid or braze all vehicle sections together.

Sometimes low SWR cannot be obtained, hence, base impedance is thought incorrect. (With a Hustler Antenna, this would normally be an improper installation and/or grounding.) A foreshortened mobile antenna, regardless of how well it's made, contains inductance or loading which causes less than optimum performance. Loaded antennas at best cannot equal the performance of full-size counterparts. So, improved performance actually means a few DB less loss.

Higher power capability and increased performance go hand in hand. However, high power capability dictates use of big wire which normally produces very high Q, very narrow bandwidth and very low base impedance. Unlike most antenna manufacturers, the Hustler people will not compromise. They select wire for Hustler antennas which permits higher current with less heating. They also select the best LC ratio between the inductance and tip-rod, length of the base section and size and pitch of the wire. Careful handling of these variables provides the optimum mobile antenna.

For high power capability, 52 ohm base impedance, widest possible bandwidth, very low SWR resonance and mechanically sound weatherproof construction, find your elusive ground. Then, for peak performance, install an *all new* Super Hustler Antenna.

Yours for top performance.

J. L. Taylor, Manager, Electronic Sales W8EEC

NEW-TRONICS CORP. / *3455 Vega Ave., Cleveland, Ohio 44113* 6437-A

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Mobile Burglar Insurance

About the most popular items on the ham market today, judging from the offerings of the major radio manufacturers, are the small relatively inexpensive transceivers now beginning to dominate the market. Not the least important aspect of this popularity is the mobile capability designed into these units. Most of us want the option of going mobile even though the probability of our doing so, except for the annual vacation, is normally quite remote. A strong argument against going mobile is the very real possibility of having the gear stolen. It isn't unusual for the radio equipment to be worth more than the automobile in which it is installed (my case); and it's a brave man, indeed, who will sleep soundly in his motel bed while the family bus is parked outside with nothing more than the car door locks to protect that new transceiver.

This article will provide some ideas for automobile burglar alarms guaranteed to discourage all but the most determined burglars. One system has been installed in my old hack for the past four years and not once has my "S" line been stolen; but what is more important, I've been able to sleep soundly at anybody's motel without the slightest worry over having the old bus and its contents disturbed.

The heart of all the simple alarm systems is the automobile horn. Using the dome light switch as an actuator the horn is made to blow whenever the door is opened. Nothing could be more elementary than this system since it involves but a single switch and a piece of hook-up wire. A recent magazine article covered this design and I'm sure its author must be a real writing "Pro" to have expanded such a simple idea into an interesting article.

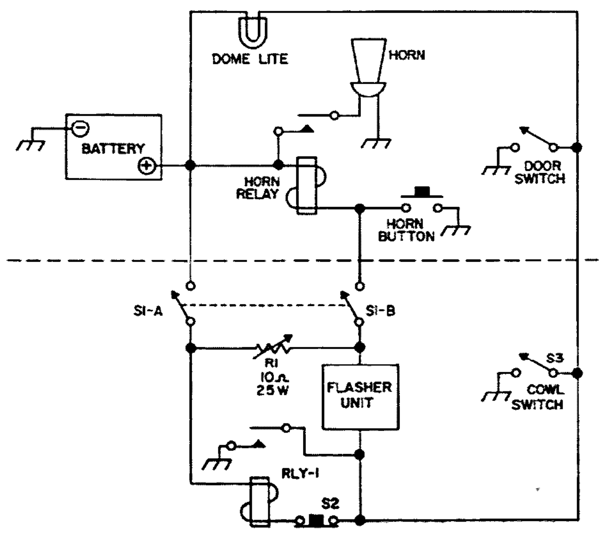

Fig. 1. Mobile burglar insurance.

A major improvement on this basic system can be accomplished with the addition of a few simple parts. With this improvement the horn will blow in a series of staccato blasts when the door is opened, and unlike the basic system which will cut-off when the door is closed, this one will continue to operate until the deactivate switch is pushed. Moreover since the horn blasts are not continuous there will be less than half the drain on the battery when the system is actuated. This could be important if you happened to be unavailable when the alarm is touched off. Additionally, it is unlikely anyone will mistake this pulsating signal for a stuck horn button.

Fig. 1 is a schematic of the alarm which I have been using. As can be seen it is quite simple and essentially differs from the basic alarm only in the addition of one relay and a turn signal flasher unit common to almost all automobiles. In theory the unit operates in this manner: With the system actuated, that is with switch S1 in the closed position, the door is opened providing a ground for the horn relay through the flasher unit. At the same time Rly1 drops into closed position providing a ground for the horn relay independent of the door switch which initiated actuation of the alarm. Current through the flasher unit causes it to heat and break the circuit rhythmically which in turn controls the operation of the horn relay and the horn. All would be beer and skittles if this were all there is to it but unfortunately there is more. The horn relay is supposed to be a 12 volt unit (12 volt cars) so anything added in series with the relay coil such as a flasher unit would theoretically prove impractical. However, most automobile accessories are designed to operate on low voltage and this is the case with the

horn relay; it will pull in at a bit less than 12 volts quite nicely, even if not so quickly as at the rated voltage. But since the alarm will operate just dandy so long as the relay pulls in at all this is no real disadvantage. The flasher unit is an unknown quantity itself unless we dig rather deeply into the complexities of the particular automobile for which it was designed. Certainly it is a low voltage high current device. What current any particular unit is designed to operate on cannot always be determined and for this reason we need R1 which by-passes enough current around the horn relay to insure operation of the flasher. The unit which I have in use is a 12 volt unit which I picked up indiscriminately in a parts store; its resistance is something less than a half ohm and seems to require about 3 amps to operate. In my unit when R1 is set at about 3 ohms the flasher operates at about the right frequency. I haven't tried a 6 volt flasher unit; it might very well work better.

Because flasher units are such unpredictable beasts even when used as directed R1 may prove something of a problem. I used a small choke which just happened to be of the right resistance. I would suggest, as a first step, hooking the flasher unit and a heavy duty variable resistor together at one end. The resistor should be about 10 ohms. Take the assembly out to the car and locate the hot wire going to the horn button. This wire will usually enter the steering column through a plug and jack arrangement. Pull the hot wire out of the connection and touch to the car chassis to see if the horn blows; if it does you've got the right wire. Now hook this wire to the end of the flasher unit connected to the resistor. Through a lead hook the free end of the resistor to the battery or a 12 volt source such as the ammeter. Now ground the end of the flasher unit which was not soldered to the resistor. The horn should begin to blow continuously. Now adjust the resistor until the flasher unit and the horn begins operating at the desired frequency. **Fig. 2** shows the test hook-up. The value of R1 has now been determined. The wattage of R1 will have to be rather large but since the horn operation is intermittent something less than half of the steady current value is sufficient. Should the resistor burn out the horn will blow steadily rather than in blasts so the basic integrity of the alarm is still maintained. About 15 watts will suffice for my installation.

Rly1 can be any garden variety of 12 VDC relay, of which there must be millions cluttering the junk boxes across the country. The only requirement is that it must have a set of normally open contacts. S3 may be omitted if the engine compartment is locked from inside the car. The function of this switch is to prevent the imaginative thief from getting at the battery and disabling the entire electrical system before attempting entry into the car. Location, type and mounting of S3 must depend on the type of car, inclination of the builder and generosity of the junk box. It may be a push button type with normally closed contacts which may be mounted wherever the engine hood will hold the switch depressed when the hood is down. Alternatively, a simple toggle switch may be used with a string tied between the switch and the hood in such manner that when the hood is raised the switch is actuated. A mercury tilt type switch could also be used.

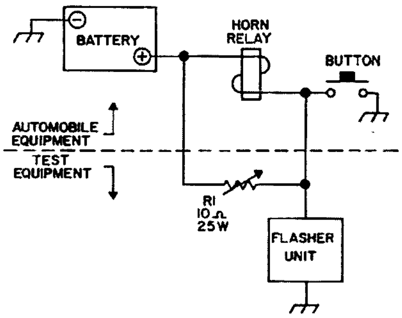

Fig. 2. Showing temporary hook-up of flasher unit and resistor R1 for determining final value of R1. R1 should be about 10 ohm, 25 watt and can be either a slide resistor or a rheostat.

Switch S2 is strictly a convenience item whose only purpose is to provide an unobtrusive but readily accessible switch for silencing the alarm once it has been set-off. SI will perform the identical function but in addition it will also disable the alarm whereas S2 will leave the system armed. I would suggest a microswitch mounted within the door and actuated by the door latch. If used, S2 should be a push button type with normally closed contacts.

Resistor R1, the flasher unit and Relay Rly1 should all be mounted on a small chassis and installed within the body of the car wherever space can be found. Switches S2 and S3 are mounted in accordance with the discussion above. Either Switch SI or Switch S2 (if used) must be mounted in an accessible place. I mounted SI (S2 not used) just behind and under a member of the radiator grillwork.

This completes the set-up. If installation of the alarm is made as directed above I defy any burglar to make off with either your mobile equipment or automobile short of using a blow torch.

. . .WA6UVS

No ham interested in working DX should ignore this article. It states some very interesting and important conclusions.

A Look at Antennas for DX

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The basic question in DX work is, how does one get the best signal between two distant points on the earth? Answering this question, from the antenna standpoint, is the subject of this article.

The earth is shaped somewhat like a globe, as shown in **Fig. 1**. Also shown is a shell surrounding the globe, which represents the ionosphere. A radio wave starting at point "A" gets to point "B" by a series of reflections, alternately off the ionosphere and the surface of the earth. Notice that the smaller angle "a" is, the fewer reflections it takes to get a signal between the two points. This is the single most important fact to keep in mind when choosing an antenna system for DX work. It is a fact of nature that a signal loses about 5 db of strength on every "skip," so if you want to work the DX reliably you must radiate your signal at a low angle. In fact, where DX is concerned, your antenna's radiation angle is more important than its gain.

Angle "a" in **Fig. I** is the angle between the local horizon (or a line tangent to the surface of the earth) and the main radiation lobe of the antenna. It is called the "radiation angle" in antenna literature. The size of this angle is determined primarily by the type of polarization used, and by the height of the antenna, although some other factors do come into play, which will be discussed later.

K6ZGQ is an electrical engineer (BS USNA 1963, MS Stanford 1965) in the Air Force who is interested in just about all facets of hamming.

So now that we know we want an antenna system with a low radiation angle, what do we do about it? Let's explore first the effect of polarization on radiation angle.

Vertical antennas

Vertical antennas of different heights mounted with their bases at ground level, and operating over a *perfectly* reflecting earth, will display radiation lobes as shown in **Fig. 2**. These are diagrams for the best results that can be achieved with vertical antennas of a given height, where low angle radiation is concerned. Notice that the radiation lobe always has a maximum value at a radiation angle of zero degrees, which looks very good for DX

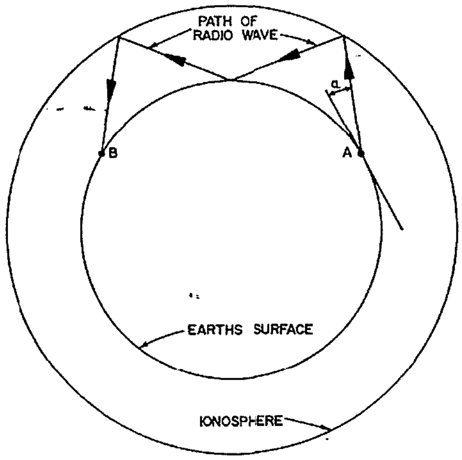

Fig. 1. The path of a signal between two distant points. For clarity, the distance between the Earth's surface and the ionosphere is greatly exaggerated.

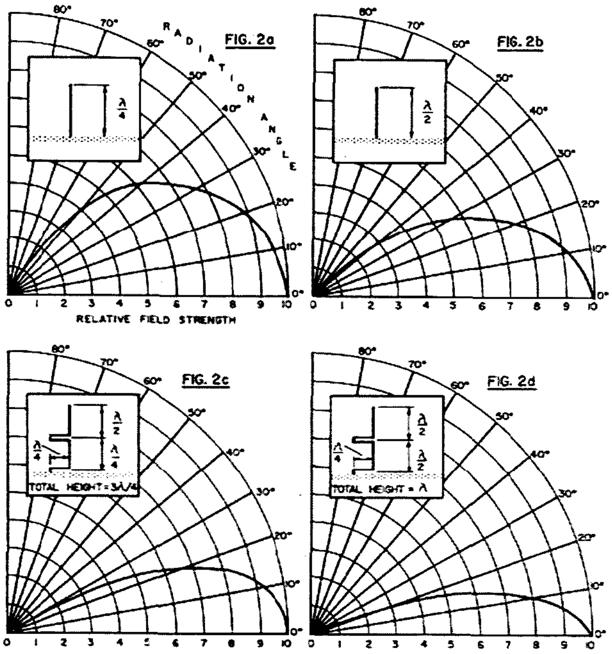

Fig. 2. Radiation angle diagrams for optimum vertical antennas, assuming perfectly reflecting ground. A. Simple quarter wave vertical. B. Half wave vertical. C. One and one-half vertical dipoles fed in phase. D. Two vertical dipoles fed in phase. The last two are known as collinear arrays. The stubs are to provide proper phase in feed currents. These four antennas represent the best radiation angle results that can be obtained with a vertical antenna of a given height. The patterns are actually symmetrical around the 90° axis, of course.

work. Unfortunately, the sad fact is that the surface of the earth is not perfectly reflecting, nor is it even close to it. The effect of the actual surface of the earth is to not only raise the radiation angle, but also decrease the signal strength by several db, for average soil.

In fact calculations carried out by the writer utilizing a digital-analog computer setup show that for equal heights above ground, *horizontal polarization is always superior to vertical polarization at low radiation angles by at least 3 db,* where DX frequencies are concerned. Anyone wishing to investigate this profound statement further is directed to references 1 and 2. A typical result derived from the computer work is shown in **Fig. 3** for a vertical antenna composed of two half-wave dipoles arranged colinearly and fed in phase, as shown in **Fig. 2D**. Notice that the signal is reduced by about 6 db, and the radiation angle raised to about 15 degrees, compared with a perfect ground. This plot was made for average soil. Dry and rocky soil would give even worse results, while wet loam or sea water would give a definite improvement.

To further deflate the esteem of the vertical antenna for DX work, let's explode two often quoted myths about the vertical. First, although a good ground system is very helpful, even mandatory, when using a vertical, *no significant improvement in low angle radiation can be expected by improving the ground in the near vicinity of the antenna.* In other words, no amount of salt on the ground around the antenna, and no number of quarter-wave radials, will significantly improve DX operation. The reason for this is that the reflections off the ground that produce low angle radiation occur at good-sized distances from the antenna, and if improvement is desired it would be necessary to provide a ground of superior conductivity around the antenna for a distance of at least one-quarter mile—a very expensive undertaking. Even then the null at zero degrees would still exist, for it only disappears with a ground of infinite conductivity.

Second, *it is not true that a vertical antenna has an inherent 3 db gain over a horizontal by virtue of its operating over its "image."* Although the image effect is present with a vertical (and does produce a 3 db gain over the same antenna in free space), it is no less present with a horizontal antenna, so neither has a definite edge here. The image effect can be visualized simply by picturing the ground as a mirror. An antenna above ground will see an image directly below it in the mirror. By use of the antenna and its image diagrams, such as **Figs. 2** and **4** can be

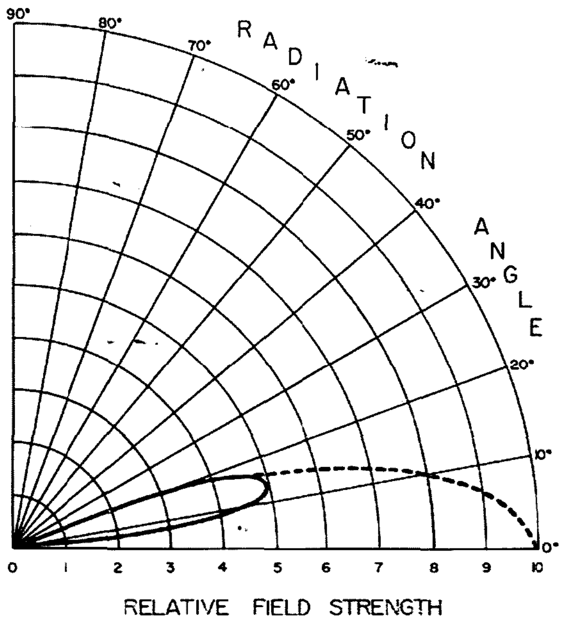

Fig. 3. The typical effect of average soil on the vertical radiation pattern of a vertical antenna. The pattern here is for the same antenna as in Fig. 2D. The dotted line represents ideal conditions (i.e., perfectly reflecting ground), while the solid line is for real ground. The actual pattern is symmetrical around the 90° axis, of course.

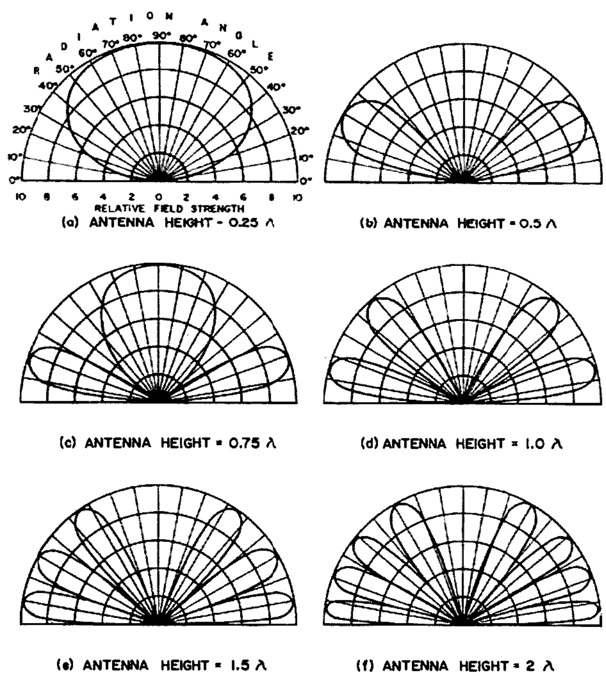

Fig. 4. Radiation angle diagrams for a non-directional horizontal antenna of various heights above perfectly reflecting ground. Only an antenna with extreme vertical directivity will greatly change these results for low radiation angles.

derived. See Reference 1, pp. 808-810 and 882-888, for further information on the image concept.

Horizontal antennas

Now let's see what the horizontal antenna can do for us. **Fig. 4** shows radiation diagrams for a horizontal antenna of different heights above perfectly reflecting ground. Note that there is always a null at zero degrees and that the lowest lobe moves to lower angles as the height is increased, although the number of lobes increases. Contrary to what may be believed by some, no antenna type (with all its elements lying in one horizontal plane) can greatly change the results shown in this figure, as far as the radiation angle is concerned. If you want a low radiation angle you must put your antenna high in the air. A happy fact about the horizontal antenna, though, is that the effect of the actual earth is not to greatly change the diagrams of **Fig. 4**. The lobes will have slightly diminished length and the nulls will fill in to some extent, but the effect is small enough that we can use **Fig. 4** with good accuracy for practical antennas.

Now let's get down to brass tacks. Just exactly what are the best radiation angles for DX work? **Fig. 5** shows this information for the usual DX bands. Notice that as the frequency increases, the best angles get smaller. Also note that there is a lower limit on the radiation angle that it wouldn't be wise to exceed. In other words we don't want our antenna too high, which is fortunate from an economic standpoint.

Let's take 20 meters for an example, see Fig. 4. An antenna height of one wavelength (about 70 feet) will give us maximum radiation between 8 and 22 degrees for the lower lobe, within the optimum range. Moving the antenna to one and one-half wavelengths height, which will increase the expense considerably, will move the lowest radiation angles down only a little. On the other hand, moving the antenna to lower heights will raise the lowest radiation angles considerably. *This is the reason that the 20 meter boys with their beams at 70 feet do much better than those of us with lower antennas,* and have little trouble competing with antennas at greater height. The point of this is that an intelligent height of one-half wavelength or less, however, the quad produces slightly lower angle radiation than the yagi will. This is due to the fact that the quad has a built-in stacking effect, since its elements do not all lie in one horizontal plane, as with a yagi. The obvious conclusion is that if you are limited to heights of one-half wavelength or less, the quad is a good antenna to look into. Above this height, however, the yagi might be better, since its construction is simpler and it can give greater gain.

As far as gain is concerned a 2 element quad has a maximum gain of about 5.7 db, while the 2 element parasitic displays about 5.4 db; the quad has a slight edge. When going to more than 2 elements, though, the parasitic yagi always has the greater gain. At the 3 element level, for example, the yagi has about 1.3 db more gain. See **Fig. 6.**

One other advantage of the quad is that it is a little less susceptible to certain types of noise when receiving than the yagi. This is probably due to the fact that the quad is a type of loop antenna. And while speaking about receiving noise we may as well take one

Band	40 meters	20 meters	15 meters	10 meters
Optimum Radiation Angles	10-35°	7-22°	6-20°	5-14°

Fig. 5. The best radiation angles for working DX in four popular amateur bands.

more pot-shot at the vertical and point out that the vertical is much more susceptible to man-made noise than is a horizontal antenna.

Another fact about the quad, which has to do with its having less gain than the yagi, is that it is inherently a low Q antenna. This means that it will operate over an exceedingly wide bandwidth with a reasonably low SWR.

The DX man torn between the quad and yagi would do well to read references 3 and 4, which cover the antennas exhaustively and are excellent, readable books.

The multi-band beam

There is a happy coincidence about using a multiband beam for the DX bands. Since the optimum radiation angles decrease as frequency increases, it is necessary to raise the antenna (in wavelengths) as the frequency is raised, if it is desired to keep the radiation angle in the optimum range. But if the antenna stays at a constant height, measured in feet, it will automatically be raised in wavelengths as the frequency is raised. The result is that a multi-band antenna for 20, 15 and 10 meters mounted at 70 feet will give near optimum radiation angle results on all three bands. This can be seen by comparing **Figs. 4** and **5**.

There is also an undesirable feature attendant with many multi-band beams. Most designs use traps and matching networks which are inherently lossy. This means that a lot of the rf is soaked up in the traps, rather than being radiated toward the DX station. The result is that multi-band beams are seldom, if ever, as efficient as a single band array.

Stacking antennas

There is another way to reduce the effective radiation angle. This is by stacking identical antennas above one another. Unfortunately, this is difficult at DX frequencies because the stacking distance must be in the vicinity of three-quarters to one wavelength to be effective. At 20 meters, for example, the minimum distance between antennas is about 55 feet. At 10 meters, though, stacking is a definite possibility for the ambitious DXer. Both antennas are fed in phase with equal currents.

To use **Fig. 4**, then, one measures from ground to the midpoint between the two antennas to find the effective height. With the midpoint at one wavelength, the upper lobe (**Fig. 4D**) would largely disappear, and the lower wave angle would decrease slightly. The result would be about a 4 db increase in signal strength at the DX location.

Number of Elements	Maximum Gain of Yagi	Maximum Gain of Quad
1	0 db	0.9 db
2	5.4 db	5.7 db
3	8.5 db	7.2 db
4	9.3 db	8.0 db
5	9.9 db	8.5 db

Fig. 6. The maximum gain obtainable from quads and yagis with different numbers of elements. The gains noted are relative to a dipole.

Conclusion

The attempt of this article has been to give a brief overall picture of the DX antenna problem. It was particularly desired to point out the superiority of the horizontal over the vertical, as well as emphasizing the importance of small radiation angles. To the writer's knowledge a discussion of the DX antenna problem such as was given here has not appeared in any other amateur journal. Anyone seriously interested in pursuing the subject further will find the answers to his questions in the listed references. These were selected for their accuracy and readability. Good DX!

. . . K6ZGQ.

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Someone Should Do Something About...!

One of the more interesting facets of amateur radio is the opportunity to participate in unique organizations loosely identified as "radio ham clubs". Upon considering that each member has progressed through a filtering process designed to eliminate all but the most dedicated, it is interesting to observe the results. First he has had to culture an interest in a very demanding hobby, subject himself to an agonizing period of learning rules, theory, customs and morse code. Next under protest, he has indulged in outrageous expenditures for equipment. Then he has been further motivated to seek out the companionship of similar individuals. Finally, he not only endures, but delights in, attendance at regular club meetings.

These meetings follow proceedings that have been universally adopted. One familiar with these rituals can freely move from one geographical location to another and find solace. Unfortunately, these rites are not documented and the uninitiated must learn them the hard way. The constitution of any given club is usually of little benefit, for example, and reference to it can only result in confusion.

The most important things to bear in mind are that the members attend these meetings for entertainment (viz: night out from the XYL), and the club president is charged with providing some type of diversion, such as a speaker. In fact, some observers are of the opinion that this is his only purpose, and his re-election is dependent upon his degree of success in this vein.

All radio club meetings are called to order 45 minutes after the announced time. This allows a period for members to indulge in a quaint pastime known in amateur radio as the "eyeball QSO". This informal preliminary event is comprised of impromptu discussion centered on three (3) general areas of exaggerated claims:

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1. Lamentation of the heavy demands placed upon one's station by rare DX operators desiring a QSO.
2. The amount of high power one is utilizing, including various precautions to insure that a minimum of 1 KW output is always maintained.
3. The vast superiority of one's equipment; the extent of the claims being in proportion to his desire to unload it.

Of particular note are the audience participation entertainment meetings where a special game is played. The neophyte would be advised to surpress his urge to fully participate in this game until the rules are fully understood. It begins with the president announcing, "Tonight will be a business meeting!", meaning he couldn't obtain a speaker.

Upon this signal, the members are alerted to critically observe the proceedings, concentrating upon finding the "debate item." As the chairman routinely calls upon each committee head for a report, some of the more dedicated members warm-up for the main debate event with comments and questions somewhat relevant to the report. Candidates for team captain can thus identify themselves.

The main debate item is usually selected between 15 and 20 minutes after the call to order, when boredom has set in. While the scope of these items are vast, there are certain criteria which must be met in order to enjoy full participation.

1. Under no circumstances must the debate item result in any additional work for anyone except the president.
2. It must not encompass anything of real consequence. Abstract and theoretical subjects are ideal.
3. It must not be so complex as to allow for more than two points of view.

After several false starts, the debate begins to unfold. The teams can be identified as play continues. The chairman must make an important decision which has a significant impact upon the organization of the two teams. If he elects to assume the neutral role of an umpire, the teams are divided by an imaginary front-

to-back line down the center of the audience. On the other hand, when the chairman declares himself a player, the division is automatically front vs. rear. Because the chairman holds a strategic position in the room (and often is a little more informed on the background of the subject), his unfair advantage is offset by limiting his team to those on the rostrum and—depending upon the size of the audience—from one to three of the front rows.

The tap-off is initiated by a potential team captain who arises and demands "that something be done!" concerning a certain item. It is imperative that he not be specific about what should be done or by whom, thus preventing a premature completion of the game. Heroically seizing the initiative, a candidate team captain for the other side recognizes the challenge and rises in reply. It is not pertinent that his retort reveal any great enlightenment—delivery is the critical aspect of winning these coveted positions. When the debate item is acceptable to the audience, they so signify by responding to the call-to-arms, and the main event can proceed.

Observing protocol, members from each team rally to their selected captain and alternately rise to repeat his argument, interspersing their commentary with items usually unrelated to the subject. The individual member can find great comfort in addressing the captive audience and is willing to endure listening to the others in return for his opportunity to get a few things off his chest. (Most covered topics: CB, deplorable state of amateur radio, TVI). Besides, 50% of the audience is on his side before even he starts.

Veteran observers are quick to point out the upswing of interest in the game since the wide acceptance of VOX keyed transmitters. Before this dastardly technical advancement, an operator could pour out his feelings into a microphone for all the world to hear (in reality, it would only be one other ham who was partially copying R3 X S4 with heavy QRM), and he could rave on until he got good and ready to manually throw the transfer switch. He now feels frustrated by automation since every time he pauses to take a breath during his discourse, he is vulnerable to being cut-off. An individual with this particular problem can be rapidly identified in everyday life by his continual interjection of the phrase, "AWWWWW," after every sentence.

In the unfortunate situation where the audience seating arrangement is such as to make the imaginary division line indistinct, an individual not quite sure of which side he has been assigned may be prompted to arise and summarize the two positions, and either offer a compromise or request a motion. This is an obvious delay of the game and he is penalized by a loud admonishment by both sides as he slinks to his seat. Outcast, he remains silent and makes note not to sit in the middle next time.

The game is completed when an arbitrary time limit is reached, usually 10:45 PM. The finale is quite rapid with the chairman dissolving the two teams by requesting volunteers to work on the problem. This is the signal that the game is over and everyone is to remain silent.

Any important items are disposed of rapidly without comment within the next 5 minutes so the meeting can be adjourned to a nearby tavern for a victory celebration by both sides. The team captains shake hands and agree, "It was good to clear the air!" Midnight having been established by XYL's, Inc. as the "time-to-be-home-from-the-radio-club-by," the "eyeball QSO" is resumed with the sky-the-limit for exaggerated claims, until the magic hour.

As the members happily return to their homes with fond memories of a battle well fought, mentally rephrasing what they said or wish they had said during their speech, the true value of the radio club can best be appreciated.

. . . K3BNS

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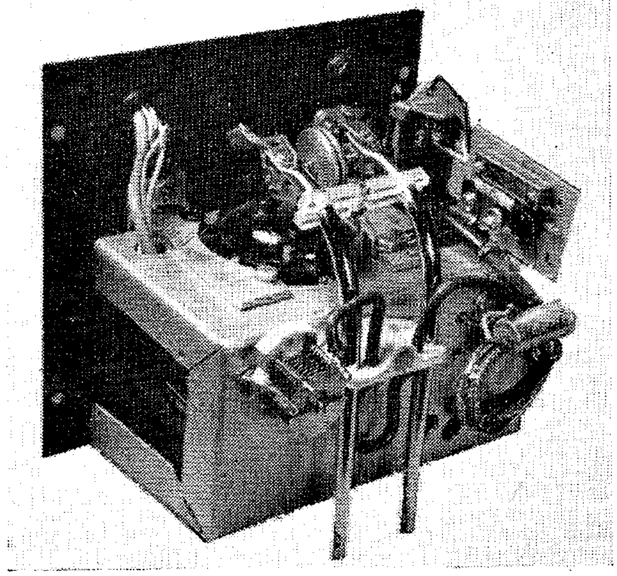
The Tranx Circuit

Switch your linear with a tranx circuit



Here's the tranx circuit installed on an 832A linear for two. The circuit is built on the small piece of insulating board at the right. The pickup loop is below the electrolytic just beneath it.

Many excellent articles on the construction of linear amplifiers have appeared in late issues of *73 Magazine*; one problem common to these linears when used with a transceiver is the problem of switching. The linear amplifier should be inserted between the transceiver and the antenna during the receive period. Since switching the linear (in and out of the transmission line) manually is dangerous during mobile operation, automatic switching performed by a relay is prefered in the interest of safety and convenience.

Often the relay for performing the switching is activated by closing a separate set of contacts added to the transmit switch on the transceiver, or the relay may be activated by the high voltage in the plate lead of the transceiver's transmitter section. Both of these methods require modification of the transceiver and both methods require the addition of long leads from the transceiver to the linear amplifier to operate the relay. The alternate method is to install a "tranx circuit" within the linear amplifier. The tranx circuit, short for transmitter-operated control, will trigger the relay as soon as a signal above a preset level appears in the transmission line to the antenna. The advantages are obvious—the transceiver need not be modified; it keeps its portability. Also, no high voltage leads are required to trigger the relay, and thus the safety is increased to both the operator and innocent bystanders. Use of the tranx circuit also allows remote triggering of a linear amplifier when contained in the trunk compartment of a vehicle. The only interconnecting lead between the transceiver and linear amplifier is the coax.

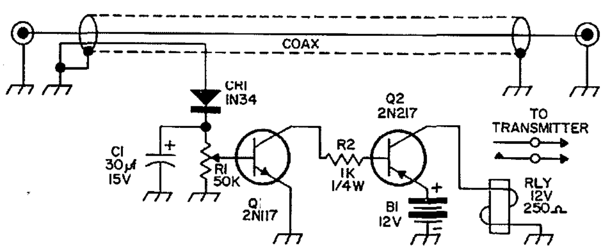


Fig. 1. Schematic of the tranx circuit. Other general purpose transistors can be used.

Tranx circuit theory

The tranx circuit is essentially a dc operated amplifier which picks up a small amount of radio frequency energy from the transmission line between the transceiver and antenna during transmit conditions and switches the linear amplifier into the circuit. During receive conditions, the radio frequency signals in the transmission line are not strong enough to activate the dc amplifier of the tranx circuit to the point of triggering the relay, which means the linear amplifier will remain out of circuit and inactive.

The circuit

The tranx circuit consists of two basis circuits, a rectifying-filtering circuit and a dc amplifier. The positive cycles of the RF picked up by the pickup loop charge C1 through CR1. After charging C1, emitter-base current from Q1 and current through R1 will discharge C1. The discharge time of C1 gave about 0.5 second delay after the signal was turned off before the relay dropped out of the hold position.

The dc amplifier circuit is comprised of an NPN transistor directly coupled through a limiting resistor, R2, to a 150 mw general purpose PNP transistor. The dc output of the PNP transistor is connected directly to a twelve volt dc relay of the type often found in surplus equipment designed for twelve and twenty-four volt operation.

Under transmit conditions, the charge across C1 attracts electrons from the emitter through the base of Q1. Electrons then flow through

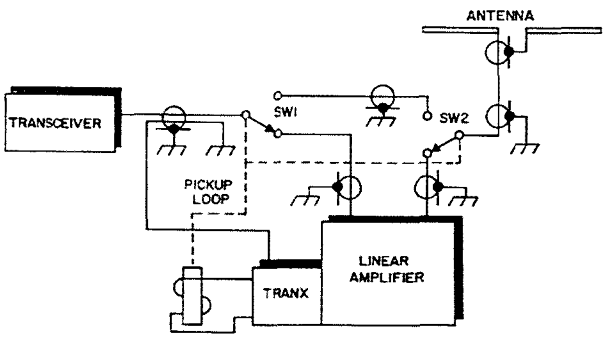


Fig. 2. Arrangement of the tranx circuit as used with a transceiver.

the collector of Q1 and limiting resistor R2, into the base of Q2, which forward biases the emitter-base junction of Q2. With the emitter-base junction of Q2 forward biased, electrons will flow from the negative terminal of B1 through the relay (closing the relay contacts) and return to the positive terminal of B1 through Q2.

Sensitivity

The only difficulty encountered with the tranx circuit came from the preliminary choice of R1 which was used to control the maximum sensitivity of the circuit. The circuit lost sensitivity when R1 was reduced below the value shown in the schematic. When R1 was increased, the circuit had a tendency to remain activated, that is, the relay would not release within a predetermined length of time after the transmitter was turned off.

Bench tests (using a VTVM and 147 mc RF source) showed that the sensitivity control could be adjusted so that signals from one volt to one hundred volts peak to peak would trigger the circuit.

Observations from field tests

The tranx circuit worked successfully when used in conjunction with a Heathkit Two'er and a twelve inch pickup loop in a mobile installation. A fifteen foot length of coax was the only interconnecting lead between the Two'er and the linear amplifier. The tranx circuit keyed easily with the rf from the Two'er, and no adverse effects (such as the generation of TVI) were observed. The current drain was also very low. Under idle conditions, the tranx circuit required about fifty millamperes. Long transmitting periods produced no noticable increase in the temperature of the transistors. However, the grid tuning would cause the relay to drop out of the hold position if not correctly tuned.

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Practical Double Sideband - 1966

Although it is not my intention to reopen the present DSB-SSB controversy, I have thoughts and suggestions which should alleviate much of the misunderstanding regarding double sideband. I have also suggested several ways of overcoming design problems of a workable modern DSB transmitter.

The main complaint most SSB operators have against DSB is the width of the transmitted signal. However, it should be remembered that a DSB signal is essentially an AM signal without a carrier, and incidentally, without heterodynes! It also should be realized that a DSB signal is two SSB signals on the same reference carrier, one upper and one lower sideband. Most complaints of splatter or distortion on DSB signals are the fault of the complainants receiver. Cost unfortunately has little to do with any patricular receiver's ability to reject local co-channel interference. All one has to do is place an attenuator pad in the receiver front end to restore that 'clean' sound to any 'suspected' local DSB signal.

Circuitry

The basic practical high level balanced modulator is shown in **Fig. 1.** Its operation will not be discussed since there are so many excellent references available such as the *New Sideband Handbook* by Don Stoner W6TNS. Basically though, the audio is fed in push-pull to the output screen grids, the rf input is in push-pull and the rf output is in parallel. The bias, shown as battery for simplicity, should be adjustable and is designed to keep the balanced modulator tubes operating within their maximum plate dissipation. It will also serve to correct any irregularities in the output waveform.

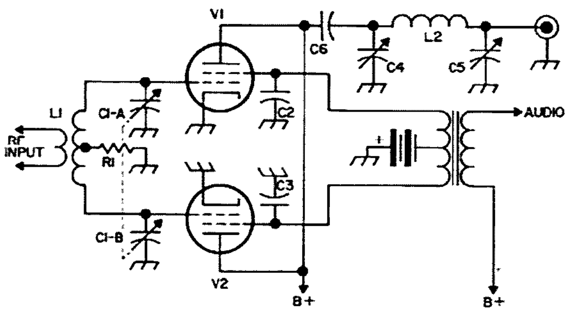


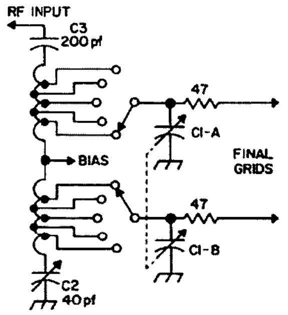
Fig. 1. High level modulator for DSB.

Design problems

Probably the biggest problem in designing a bandswitching DSB transmitter is the actual bandswitching circuitry in the final grid. Leads must be kept as short and symmetrical as possible. The most practical found by the author is diagrammed in **Fig. 2.**

The circuit is, in practice, driven by an untuned buffer stage which is controllable as to drive. C2 acts as 'drive peak' control and also balances the rf applied to both balanced modulator tubes. If careful, symmetrical construction in used carrier should be in the order of 30-40 db. The switch wafers should of course be ganged to switch the exciter stages and the final output circuitry too!

The choice of a suitable modulation transformer seems to cause some amateurs a great deal of trouble. I have found that 400 cycle power transformers are probably the best choice for several reasons. The first consideration is that the transformer must have a turns ratio of around 5.2:1 in order to develop sufficient screen voltage from the modulator. Incidentally, the transformer is connected as step-up. That is, the 117 volt primary is connected to the audio and the secondary (center-tapped) goes to the screens of the high-level balanced modulator, refer to **Fig. 1.** Another reason for choosing this transformer is the fact that it will reject any low frequency components. This will reduce intermodulation distortion and will, in effect, place the two sidebands farther apart since the information is to be transmitted at higher audio frequencies. It is also advantageous to roll off the high frequencies. This will keep the signal from becoming too broad. A low pass filter such as



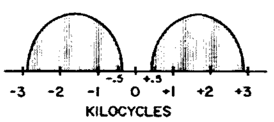


Fig. 2, Left. Bandswitching final grid circuitry for a DSB transmitter. Keep leads short and symmetrical.

Fig. 3, Right. DSB spectrum.

the Stancor C-2340 should give the desired response, 300-3000 cycles. Spectrum-wise the signal should look like that in **Fig. 3.**

Another object of concern are the ratings of such a transformer. As hinted earlier the 117 volt 400 cycle seems about best to match the output of such tubes as 6AQ5, 6V6 etc. as modulators. As a 'rule of thumb' the secondary of the transformer should be able to supply (assuming 117 volt input) about twice the combined screen voltage of each balanced modulator tube normally operating AM phone. A transformer with a secondary delivering 300 each side of the center tap has proven to be an excellent choice for modulating such tubes as the popular 6146 and 6DQ5.

Most manufacturers of transformers make 400 cycle equipment under military contract. Although these transformers are not available from distributors they may be found as surplus or alternatively by writing any of the larger manufacturers.

Another very definite design problem is mode switching. With proper design it is possible to obtain 350 watts PEP on DSB, 150 watts CW, and 100 watts AM all from a pair of 6DQ5's.

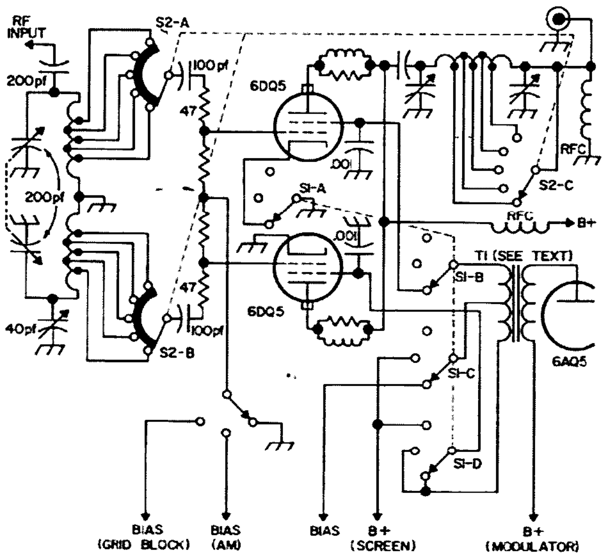
As with any problem in order to solve it you must first understand the basics. In switching between modes you are, in effect, simply changing conditions of the balanced modulator tubes. By this I mean you are changing bias, modulators and circuit configurations. In order to change your DSB high level balanced modulator to AM you must: lift one cathode of an output tube, remove screen voltage from this same tube and then switch the modulator transformer into the other tubes screen circuit in a fashion which will modulate its screen voltage and then supply a proper amount of grid bias to keep the tube from taking off in the absence of drive. For CW the following should be done; one cathode of an output tube should be lifted from ground, the screen voltage from this tube likewise should also be lifted. The remaining tube should have grid-block keying bias applied and fixed screen voltage. Circuitry for such switching is shown in **Fig. 4.** By the time all the band-switching and modeswitching circuitry is incorporated in the overall schematic it appears quite complicated. However, it is a simple matter to resolve any and all of the circuit into simpler portions.

Since the mechanical design of a DSB transmitter or any transmitter is an involved procedure it will not be covered in detail. The most important factor in designing a DSB transmitter is a symmetrical mechanical and electrical construction in the balanced modulator circuitry.

The transmitter should be carefully constructed using all current construction procedures. Keep all ac wiring close to the chassis to avoid hum pickup. Shield all critical audio leads and properly bypass all high voltage leads. As a last word on electrical design let me say that good signals require good power supplies.

Assuming that a DSB transmitter has been built you will want to check its operation on an oscilloscope. The familiar bow-tie pattern is the desired shape when rf is applied directly to the vertical plates and audio is applied to the horizontal plates through a voltage divider as shown in **Fig. 5.** The desired waveshape is also shown.

If difficulty is found in attempting to obtain a bow-tie pattern it may be because there is too much or too little drive or the bias on the



NOTE: BANDSWITCHES SHOWN IN 10 METER POSITION.
MODESWITCHES SHOWN IN DSB POSITION. POSITIONS CLOCKWISE ARE DSB - AM - CW.

Fig. 4. Practical double sideband modulator-output.

balanced modulator screens is too high or too low. In particular, the bias on the secondary of the modulator will affect the crossover point on the pattern. Drive will cause the pattern to bulge or become concave depending on whether too much or too little drive is applied. If in doubt regarding your particular pattern consult one of the many excellent handbooks available. Incidentally, a single audio tone is all that need be applied to obtain a bow-tie on DSB whereas the familiar two-tone test is used on SSB to obtain the same pattern.

That's it! I have presented a few practical hints for building a DSB transmitter. This modes popularity is still growing as witnessed by several new transmitters appearing on the market. The mode is extremely practical from practically all aspects and above all it is extremely simple as compared with SSB.

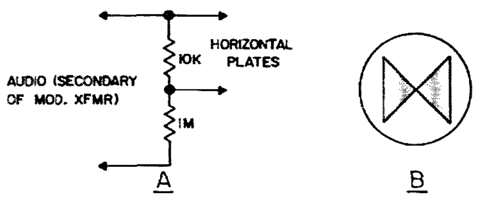


Fig. 5A. Source of horizontal sweep for a bow tie pattern shown in 5B.

In closing, if any readers are interested in complete construction details of a bandswitching 350 watt DSB transmitter drop a note to my QTH and I'll do my best to try to write such an article.

. . . VE7BBM

A. Thivierge VE2HE

A Semi-Switchless Directional Coupler

Ever since I built my first "Monimatch" SWR indicator, I have felt that simultaneous monitoring of the *Forward* and *Reflected* components would be desirable. I would all too frequently find myself trying in vain to tune for minimum *Reflected* only to find that I had the switch in the *Forward* position! Or (that was before I grew a third hand . . .) I would get annoyed at flipping the switch back and forth tuning for a healthy *F* reading . . . and get a healthier *R* reading. I considered using two meters, but the thought of such lavish extravagance was swiftly brushed aside everytime Junior needed new shoes. If other hams have run into the same problem (no, not Junior's shoes . . .) here is one answer to our common plight.

I use a zero-center microammeter. The connections to the *Reflected* diode are reversed to produce a negative output. No confusion now: positive reading for *Forward* and negative for *Reflected.*

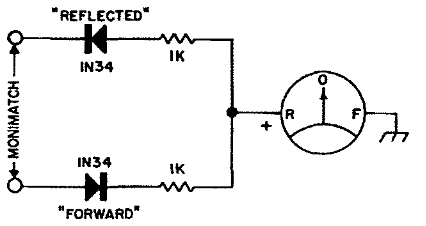


Fig. 1. Use of a zero center microammeter for the Monimatch.

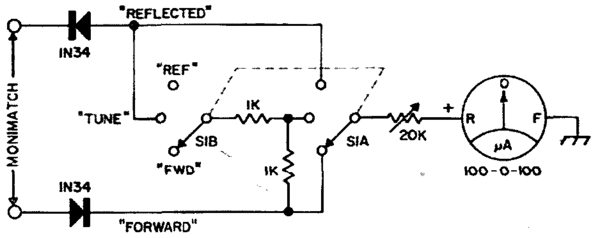


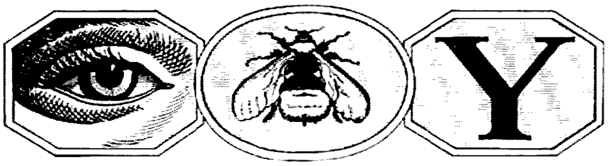
Fig. 2. Final circuit which gives conventional **Forward** and **Reflected** readings as well as the special **Tune** position.

The next logical step quickly suggested itself. Since the outputs from the coupler are of opposite polarities, why not mix them in a common load and read the resultant? It works. Se **Fig. 1.** Two 1 k resistors in series are bridged across the *F* and *R* terminals of the Monimatch and the microammeter connected to their junction point reads the algebraic sum of the two voltages: *A maximum positive deflection indicates minimum SWR.*

The necessary connections are made through a three position two pole switch. See **Fig. 2** for complete wiring. This provides a center *Tune* position giving the configuration shown in **Fig. 1** as well as the conventional *Forward* and *Reflected* positions.

Simply switch to *Tune* and manipulate all loading and matching controls to obtain a maximum positive deflection. You may then switch to *F* and *R* in the normal manner to verify the results of your knob twiddling. But after a while you won't bother.

. . . VE2HE



Ron Gunn WA6KLL
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Two Buck Monitor

Gather round, all you poor harassed ops who are getting hot on your cw or want to and who own a monitorless transmitter or sideband transceiver. Some of those rigs are pretty hard to hook a monitor to so you can tell what you're sending. You can install a noisy relay to operate the monitor, but there is a better and cheaper way in most cases so why not use it? Let's live modern and come up with a two buck monitor scheme that will plug right into the key jack and let you know how your keying sounds. Not only that, but it has no other wires or leads than the line to the key jack and a place to plug in the key itself.

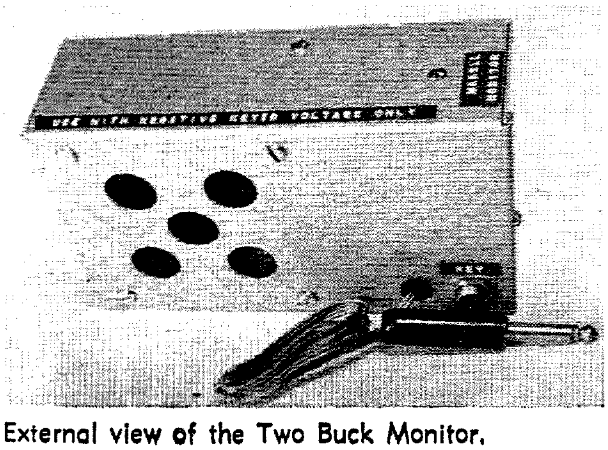
The really best way to monitor your sending is to listen on the station receiver but if you own a transceiver, forget it. The next best way is to have an audio oscillator that is keyed along with the transmitter. The best bet in audio oscillators today is the 98¢ transistor module variety that is in practically all of the mail order catalogs. These units are the most in simplicity. Wire up a small 6 volt battery and a speaker to them and they will operate for months, and drive you out of the room with their volume to boot. And you can use the unit for a code practice oscillator if you're really rusty, then plug it into the rig when ready to go.

Now the trick is to hook this thing up to your transmitter when the key is operating a circuit that is from 30 volts and up, and of any polarity. Well, if the voltage is high enough to be downright dangerous, don't be a hero, install a double pole relay and live a while. But if the voltage is a couple of hundred or less, science has found the answer, and the quantities they make these things in has driven their price down to less than four bits. I am speaking of the fantastically efficient, tiny and enormously valuable silicon power diode.

These units have a forward drop (conducting mode) of less than 0.6 volt at full rated current. As far as any circuit we might want to operate thru it is concerned, it isn't even there. The reverse resistance is another story, however. When the cathode of one of these diodes becomes positive, the series resistance jumps to many megohms.

Our problem then is to hook up the two circuits we are interested in without their interacting. By interacting I mean preventing the voltage in the keying circuit from changing the solid state components in the monitor into low grade resistors. The two circuits I speak of are the keying circuit itself (necessary!) and the monitor circuit we would like to operate at the same time.

First, determine the polarity of the transmitter keying circuit. If the transceiver is block-grid keyed, it will be negative. If it is a modulator balance/unbalance scheme or a tone oscilllator, it may well be postive. If you have to install the keying yourself or it is obvious from the schematic, fine. If not then plug in a phone plug with the plastic handle



External view of the Two Buck Monitor.

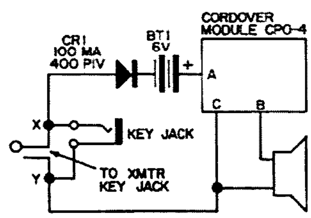
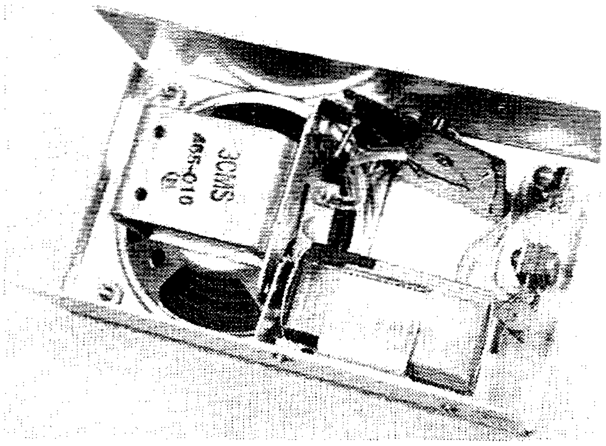


Fig. 1. The Two Buck Monitor using the Cordover CPO-4 module.



Inside of the Two Buck Monitor. The cordover module is just above the battery.

removed and determine what polarity is on the tip with a voltmeter. Be right or the two circuits will interact as explained above—once. The odds are 50-50.

Now gaze upon **Fig. 1.** In it is shown a scheme for isolating the two circuits in question from each other while operating them off of the same key. The silicon diode mentioned above has solved our problem. When the key is up, and our schematic assumes that we use block-grid keying (negative), the negative voltage at the key goes to maybe a couple of hundred volts. This voltage would instantly ruin the monitor except that we have installed the diode in series with it and have polarized it such that the negative voltage on its anode has cut it off and the monitor never sees any voltage thru it. When the key is down the keyed circuit sees ground and the rig turns on. At the same time the monitor circuit sees a continuous circuit thru the key, the now forward biased diode and the battery. It has also been turned on.

Now, if you happen to have postive voltage at the key jack, just disconnect the monitor part of the circuit at the key (points x and y) and reverse them. Then be sure to label the monitor either postive or negative as the case may be. The wrong polarity will ruin it. Mine has the statement "use with negative keyed voltage only" on it as can be seen in the photo.

If you go hog wild as I have and get a pretty box, etc., the cost will be more than a couple of bucks, but the basic parts are not far from it. By the way, if the contacts on your bug are the least bit dirty, the monitor will tell you quick. It is very sensitive to resistance in the keyed circuit and will greet you with a different note on your dahs than you get on your dits. Your V may sound like it's straight from Beethoven. The cure? Clean the points, of course. . . . WA6KLL

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Listowel, County Kerry
Eire

Controlled Audio AVC System

The two essential requirements of the Audio derived avc system are (1) fast rise time, (2) controlled decay time.

Lack of fast rise time means that on the first syllable of a modulated wave or the first dot or dash of a CW signal, an annoying blast of sound is received because the incoming signal has not had sufficient time to generate and apply bias to the controlled valves then running at maximum amplification.

Slow decay time, to the users' choice, is desirable, but fast enough to allow the controlled valves to reach full sensitivity reasonably quickly at the end of transmission, and ready for the next weak incoming signal as required, and also slow enough to allow the user to read the value of the incoming signal from his S meter needle before same returns to zero.

The last two requirements are conflicting in that too slow a decay time enabling the S meter needle to remain reasonably steady will not allow the set return to full sensitivity quickly enough, or vice versa, with the set quickly sensitive, the meter is unreadable, due to its fast movements.

Elaborate circuits have been devised to overcome these failings but complicated systems are enough to make set owners shy free of incorporating them in their receivers; therefore, a simple system that has the necessary requirements and gives steady meter reading is desirable. Such a system is now outlined in circuit, where it is noticeable that the reasonably slow decay time for the avc line and the very slow decay time for the meter, are now separate functions.

The incoming signal is applied to the grid of first section double triode, which has an unbiased cathode resistor allowing this section to work undistorted with strong or weak signals. The amplified output of this valve is passed via .01 mfd condenser to the cathode of the second half of valve which cathode is connected to earth via a crystal diode with the negative blocking end to cathode. The cathode and grid components of this section are so interconnected that a negative mean level of bias maintained on the grid, following slightly below the signals on the cathode. Thus the tips of the rectified audio voltage at the diode are passed from the cathode to the grid to charge the 25 μf condenser and also from cathode to anode to the avc line through the 10 k resistor to charge the .1 μf condenser. The time constants of the controlled grids is made deliberately small (e.g., through 50 k

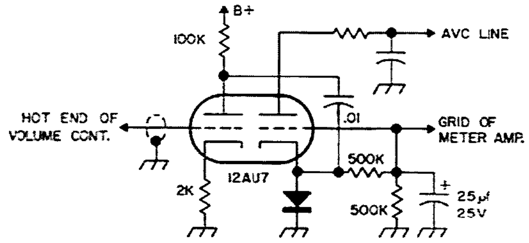

Fig. 1. Controlled audio AVC system.

resistors with grids bipassed with .005 µf condensers) thus allowing the avc line decay time (about two seconds) to depend on the value of the .1 µf condenser in this circuit. The decay time can be varied to suit users' choice by increasing or decreasing the value of this condenser.

Any movement of electrons in a diode, valve or valve portion acting as a diode, due to the constantly changing polarity of anode in respect of the cathode resulting in reversal of electron charge movement with the valve or diode will cause noise in such circuits as detectors mixers or any non linear device, which will add to the overall noise background of the receiver. The peculiar arrangement in the circuit of the diode and its associated components were arranged in an effort to cancel out the reversal of valve space current, either from the anode to cathode or grid to cathode. The eventual negative charge on the valve grid by the storage charge of the 25 µf condenser will cancel out reversal of electrons from anode and grid to cathode. The cancellation of this noise source to the anode which is connected to the controlled valves, which can amplify any source of noise, leaves us with a much quieter receiver, an advantage not to be ignored. The 25 µf condenser is also connected to the meter circuits and has a slow time constant allowing the meter to remain steady long enough for comfortable reading.

The components of the circuit are not in any way critical in values leaving some latitude regarding choice of components. Most any crystal diode in good working order will suffice. For greater values of avc levels, a 12AT7 value may be used to replace the 12AU7 without changing any components. Placement of valve and parts is not critical, but if placed away from the audio source, a screened lead from audio source to the valve input should be used to prevent grid hum through the set. A simple type of dc bridge amplifier such as the common 6C4 circuit can be used. Maybe your S meter is sensitive enough without an amplifier. This is left to the reader's choice.

. . . EI4R

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University City, Mo.

One-Way Dual Battery

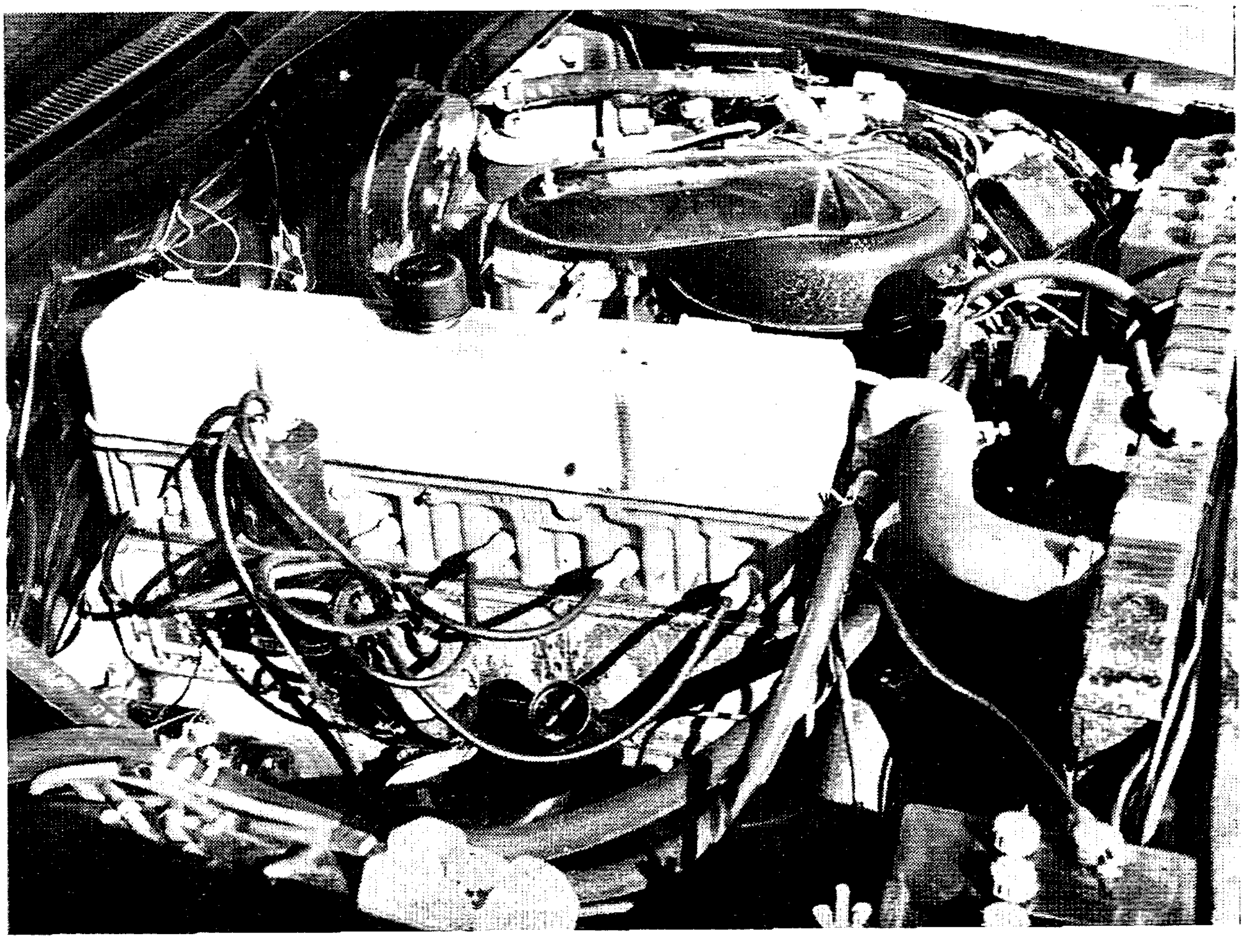
Use a unique one-way dual diode circuit and never worry about your car battery again.

Sometime ago I decided that I wanted to be able to operate my amateur gear without ever having to worry about the car's battery going dead. Having experienced the unpleasantness of not being able to park for a while during the winter, with the engine off and the heater on, or transmitting to my heart's content, I considered at first having a spare battery in the trunk and hooking it up by cables to the charging system under the hood. As I thought about it further, however, I realized that with this system I would need heavy cables so that no voltage would be lost, I would lose a bit of trunk space, I would have to do a lot of work (I don't like doing more than I have to), and I could just as easily run down one battery as two—thus gaining only a few more minutes of total electrical power.

I had to have some way to increase my automobile's stored electrical energy (battery power) and at the same time arrange it so that I wouldn't have to switch between the batteries when I was using the system or connect them for charging—automation was my answer.

Deciding on the ultimate solution, I decided to use a dual-diode, dual-battery circuit, which permits two batteries to be installed

View of the engine compartment of the car showing the two batteries and part of the diode heatsink.



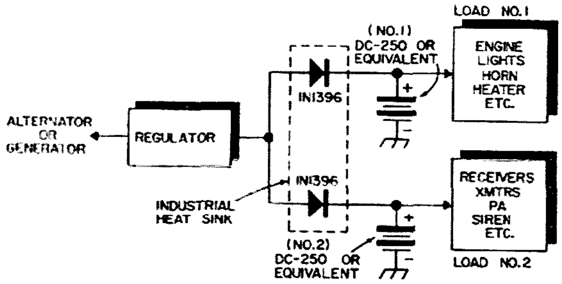


Fig. 1. Schematic of the one-way dual diode, dual battery system.

under the hood and enables charging of both batteries simultaneously but eliminates forever one's not being able to get his car started in the winter or after he has talked too long and run down the battery. As can be ascertained from the diagram, the car's electrical load (lights, horn, starter, heater, etc.) are on one battery; and the amateur load (receivers, transmitters, PA system, electronic-siren, police and aircraft receiver, etc.) are on the second battery.

Since the diodes conduct in only one direction, current output from the alternator flows freely through the diodes to the batteries but since the diodes will not conduct in the reverse direction, one load cannot take current from the other battery.

I used Westinghouse 1N1396 diodes which are rated at 50 PRV @ 70 amps and mounted the two on a Westinghouse industrial heatsink which is available from that company's Youngwood, Pennsylvania plant. The heatsink is mounted under the hood and has provided several years of maintenance-free service. Incidentally, to store the most power possible, I replaced the original battery with a Delco high capacity DC-250 and got an identical one for the other side of the engine compartment.

Since there is a slight drop in forward voltage with the diodes in the charging circuit, it is a good idea to have the voltage adjustment on the regulator turned up to compensate for this.

One never knows the feeling it is not to ever have to worry about another dead battery. If one leaves the heater on too long in the winter or the air-conditioner on too long in the summer with the engine off, he can always "jump" the power from his #2 (auxiliary equipment) battery. If he likes to yak from his mobile and talks too long on his #2 (auxiliary equipment) battery and drains it completely, he can do it knowing that he will still have his fully charged #1 (automobile equipment) battery with which to start the car. You can't beat it!

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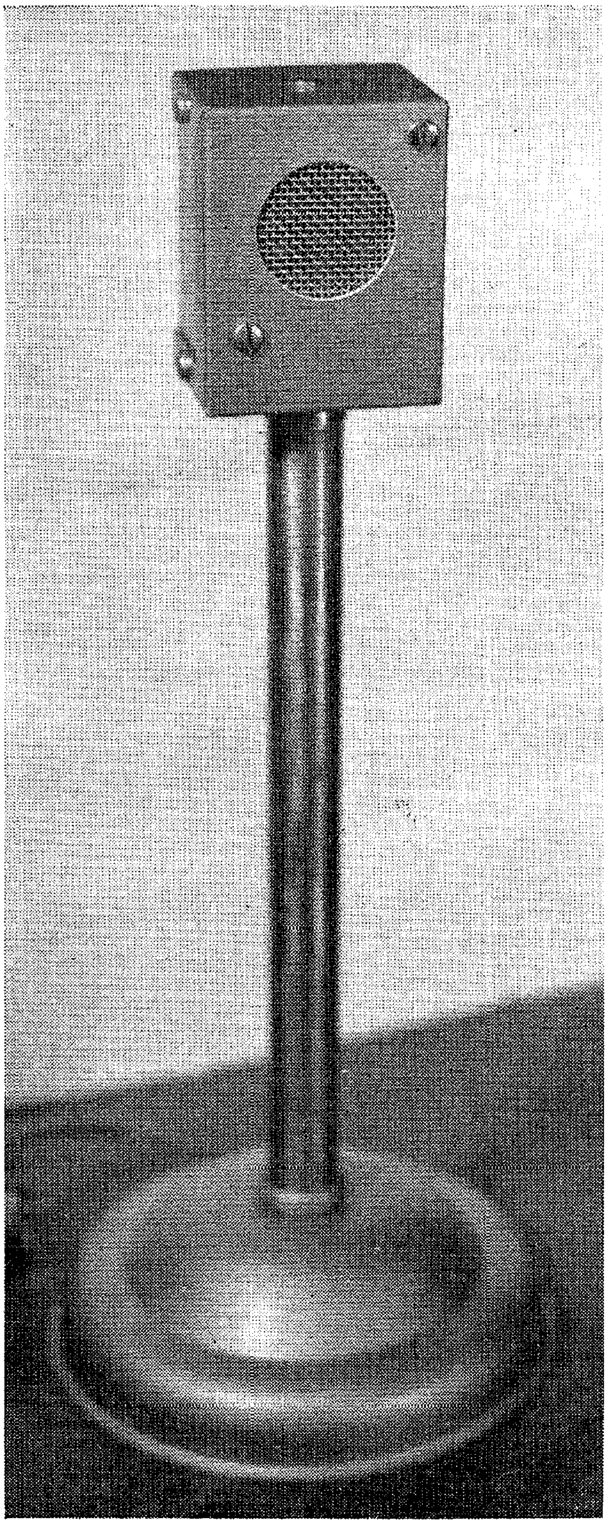


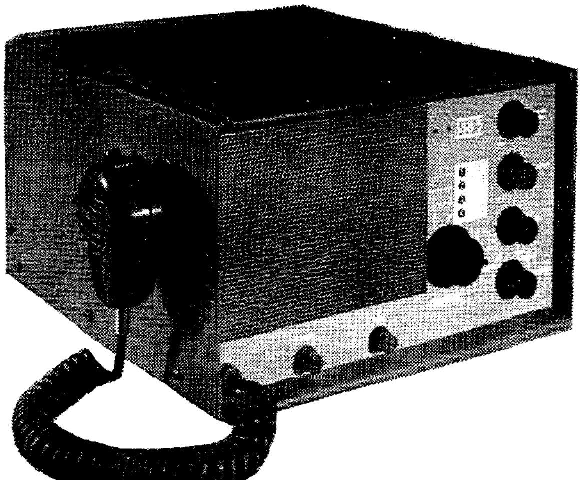
A Dynamic Microphone at Low Cost

Richard Genaille
719 Quarterstaff Road
Winston-Salem, North Carolina

For many years radio amateurs have obtained, by various and sundry means, the popular Western Electric F1 Transmitter Unit for use as an excellent carbon microphone at the home station or for mobile and portable work. While the F1 Unit performs admirably, it also has certain disadvantages, such as the need for providing operating current by the use of an external battery or by modifying speech amplifier circuitry to utilize tube cathode current. Excessive carbon button current very often results in packing of the carbon granules and unsatisfactory operation. Very often an operator will complain of hearing carbon mike hiss on your signal.

On the other end of the F series type telephone hand-set, of which the F1 Transmitter Unit is a part, is the unit known as the Western Electric HA-1 Receiver Unit. To most hams this part of the telephone hand-set has had little significance other than to be the part that you normally would listen to when using the hand-set. Unknown to many hams is the fact that the HA-1 Receiver Unit can be used as a microphone with excellent results in providing good voice communications quality. It is a controlled diaphragm magnetic

Attention MARS Members:



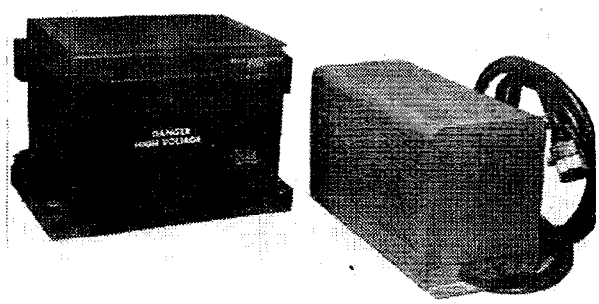
A Very Limited Offer

An unusual opportunity exists for hams who have an interest in MARS or CAP to purchase a brand new RCA SSB-5 transceiver. This 4-channel transceiver covers the range of 3-15 mc and provides a means of switching any one of 4 discrete frequencies within this spectrum with a flick of a switch. All circuits from the crystal to the output pi are switched by this control, and when you tune up for any one specific frequency you tune the entire transceiver with a separate set of adjustments for each channel. There are provisions for 4 antennas and you get a choice of a 6-pole lattice filter for either upper or lower sideband. The unwanted carrier and/or opposite sideband is rejected by more than 50db while permitting more than 125 watts of PEP output.

Here is a device, the best of its kind for MARS operation, currently selling for $742.50, absolutely new. I have a total of only 46 of these units available for sale which I will sell to the first 46 customers who send in their money. This is what you will get for $249.50: The transceiver; one crystal of your choice between 3 and 15 mc (this crystal will always be 1400 KC higher than the frequency you want to operate on); either 110 AC supply or a supply that will operate on 12 volts DC for use in a motor vehicle; the crystal lattice selectable sideband filter that you wish, either upper or lower, or you may buy the other filter for an extra $50.00; interconnecting cables; and the instruction manual.

The transceiver weighs only 16 lbs, the AC supply 23 lbs, the DC supply 8 lbs. It measures 12½" x 7½" x 13". The receiving section itself has extremely good sensitivity, being better than 1 microvolt for 50 milliwatts output with a 10db signal plus noise to noise ratio.

By the way, you get the push-to-talk microphone and the built-in speaker as part of the package. You have automatic speech clipping up to 12db, and each crystal of the 4 that you can use is housed in a thermostatically controlled oven which is supplied as part of the gear. You can match any antenna from 10 to 80 ohms including whips. The front panel controls include a pilot lamp to show the set is on, a modulation indicator, and emission control which provides for either upper or lower sideband output or either sideband with carrier. In other words, you can go AM with this rig. You have a trim control which gives you the means of tuning up to 75 cycles on any incoming signal, and you have both an RF gain control and a power output gain control.



This is late, modern equipment, new, checked out, guaranteed and sold on a money-back basis; $742.50 worth of new sideband gear for $249.50 special only at

HERBERT W. GORDON COMPANY

Woodchuck Hill, Harvard, Mass., 01451
Telephone 617-456-3548

type receiver unit similar in operation to a permanent-magnet type loudspeaker. As is already well known in amateur circles, a permanent-magnet loudspeaker can be used as a dynamic microphone, although the fidelity is not as good as is obtainable with a properly designed microphone. Likewise, the HA-1 Receiver Unit can be used as a dynamic microphone, but with superior results. It has a more desirable frequency response for amateur communications work than most of the low-cost crystal microphones presently flooding the market, is physically rugged and is not easily affected by shock, heat or humidity. The HA-1 can now be obtained, without recourse to "various and sundry means," at a nominal cost. With a small amount of effort, a few additional components and some miscellaneous hardware, you can make up a good communications quality dynamic microphone which you can use at your station as either your main mike or as a rugged mike for mobile and portable work. Here is how it is done.

Since the output impedance of a typical dynamic type unit such as the HA-1 is quite low, it is usually desirable to provide some means of impedance matching to a high impedance microphone input. This is most often accomplished by the use of a small matching transformer normally mounted inside of the case in which the dynamic unit is installed. To determine the characteristics of the transformer required for matching the HA-1, an impedance curve was plotted for the HA-1 Unit using measurements made with a Knight-Kit Sine Wave Audio Generator and a Knight-Kit Vacuum Tube Voltmeter. From this impedance curve it was found that the impedance of the unit varies from about 60 ohms at 300 cycles to near 400 ohms at 5,000 cycles. For normal voice work we are primarily interested in those voice frequencies which lie between 500 and 2,500 cycles. To obtain the necessary impedance match for the HA-1 Unit to a high impedance connection and to keep the dimensions of the matching transformer as small as possible, a U.T.C. Sub-Ouncer miniature transformer was selected for the job. The particular model, the SO-1, is physically small enough to locate within the metal box which will ultimately be used as the mike "head." It has a primary impedance of 50/200 ohms and a secondary impedance of 62.5k to 250k ohms. The response of the SO-1 is plus or minus 3 db from 200 to 5,000 cycles. This small transformer is the only item required for the microphone construction that costs in excess of one dollar. The entire microphone, stand and all, can be constructed for no more

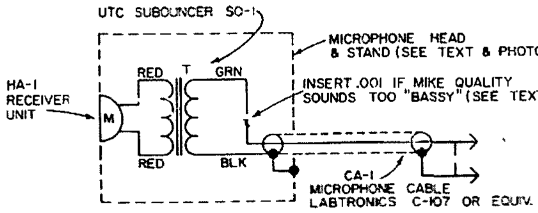
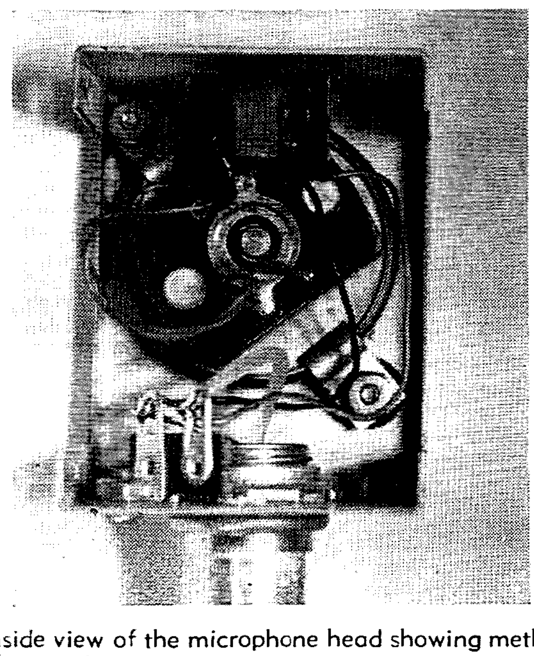


Fig. 1. Schematic of the low cost dynamic microphone using the HA-1 receiver unit.

than about $6.50 if all of the material, including the HA-1 Unit, is purchased new.

The interior of the microphone "head" and the completed microphone with stand are shown in the photographs. Needless to say, one does not have to adhere strictly to the miscellaneous hardware used by the author as there are probably many variations of mounting that would be entirely satisfactory. The HA-1 Receiver Unit and the SO-1 matching transformer are mounted in the $2\frac{3}{4}$" x $2\frac{1}{8}$" x $1\frac{5}{8}$" aluminum Minibox. A hole approximately $1\frac{3}{16}$" in diameter is cut in the section of the Minibox which is to serve as the front of the mike. For appearance's sake, a small piece of aluminum screen wire is placed over the hole on the inside of the Minibox section. The HA-1 unit is positioned centrally over the wire screen and hole and fastened securely with small cable clips. The SO-1 matching transformer is mounted by means of a small copper strap as shown in the photograph. The author used a small dab of nail polish to prevent the transformer from sliding out from under the strap in the event that the microphone is dropped. A lug type terminal strip was



Inside view of the microphone head showing method of mounting parts.

mounted inside the Minibox to facilitate interconnection of the transformer secondary leads to the conductors of the microphone cable. The schematic is shown in **Fig. 1.** The transformer primary leads are soldered to the HA-1 unit directly, taking care not to use excessive heat when soldering. The black secondary lead is used as the ground lead and is connected to the shield of the mike cable as well as to the microphone case. The green secondary lead connects to the mike cable inner conductor and is the grid connection. The mike stand proper is made up of a Sylvania #P3305 Pendant Canopy, sometimes known in electrical supply houses as a canopy cover, into which is clamped a 9″ length of ½″ thinwall electrical conduit. A Thomas & Betts "Socks" conduit connector is pushed on the opposite end of the piece of conduit and is inserted into a hole, large enough to admit the connector, which has been drilled in the bottom of the Minibox. A hole large enough to accommodate a ⅜″ rubber grommet was drilled in the canopy cover mike stand base. The mike cable is passed through the grommet and up the piece of conduit into the Minibox where it is then connected as mentioned previously. The sharp-eyed reader will probably notice a hole cut in the rear cover of the microphone case and covered with aluminum screening. This hole was cut by the author since it seemed to improve voice quality in the author's unit. The decision to include this opening was made after trying out the microphone with and without the Minibox sections completely assembled. The only explanation coming to mind for this behavior is possibly that of sound wave reinforcement of cancellation due to the waves striking the rear of the HA-1 Receiver Unit diaphragm. If after testing the microphone it appears that the quality is a little on the bassy side, a characteristic common to many dynamic microphones, a small capacitor on the order of .001 µf can be connected in series with the grid side of the mike cable. Less capacitance will provide more restriction of the lower frequencies. The addition of this capacitor may be accomplished at the speech amplifier input grid end of the circuit or within the microphone head.

Your completed dynamic microphone should, after following the preceding instructions, look like the completed unit shown in the photograph unless you chose to assemble the components in a different manner. You are all set to connect the mike cable to your transmitter audio section and to receive compliments on your low cost dynamic microphone.

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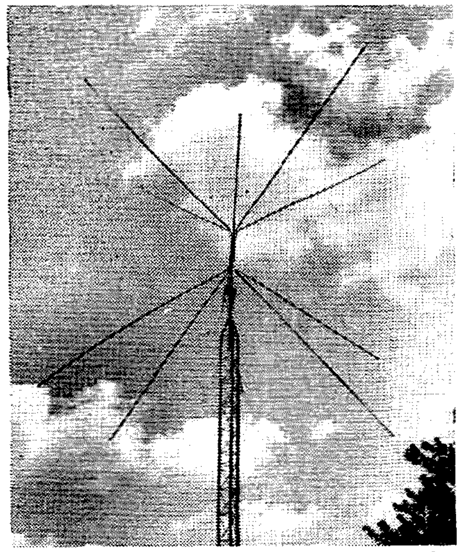

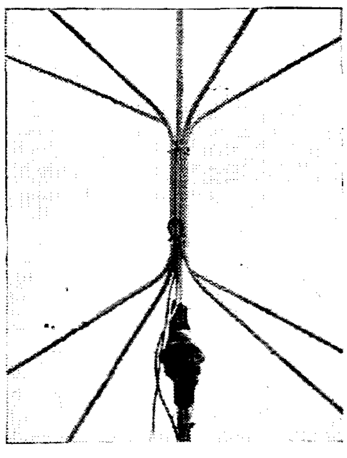

Use this simple scheme to couple two antennas to your receiver for better reception.

Diversity the Easy Way

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The active VHF enthusiast is primarily interested in consistency and faithfulness in reception of DX. In fact this idea of strength and continuity ranges through the expressions of many in our history. Through poetry Browning tells us:

Then, God for King Charles! Pym and his snarls
To the Devil that pricks on such pestilent carles!
Hold by the right, you double your might;
So, onward to Nottingham, fresh for the fight.
March we along, fifty-score strong.
Great-hearted gentlemen, singing this song!

(From *Cavalier Tunes*, Robert Browning.)

Diversity, the technique using the best possible signal obtainable from one antenna instantaneously and automatically selected from a multiple antenna array, each antenna separated horizontally by a large distance, certainly is a worthwhile method for realizing the subject specifications for VHF reception.

WA2MTB is a student interested in experimenting.

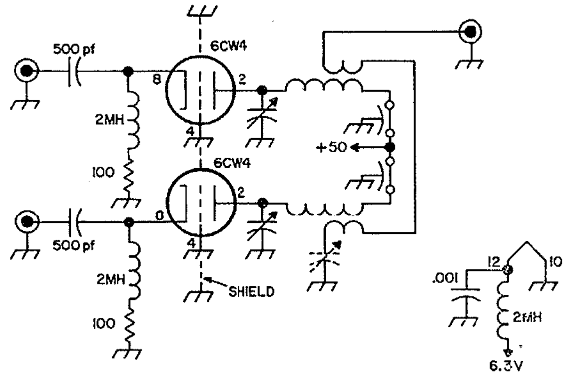


Fig. 1. Schematic of the simplified diversity adapter.

Although this technique has not been described as much as it should have been in the leading amateur radio journals, significant advances have been made in this field by many individuals and by the "pros" in the realm of high fidelity FM broadcasting. Requisite reading on diversity is the article[1] by two engineers of Hermon Hosmer Scott, Inc.

When diversity is mentioned, many think of the relatively expensive mean by which it may be accomplished, and installed. That mean is the use of two or more VHF antennas separated by at least three wavelength horizontally connected to separate, individual radio receivers employing "interstation noise suppression" (squelch) with each audio output paralleled. But this requires at least two, identical VHF receivers!

Instead of the obvious expense that is incurred by use of the above, paralleling the antennas together and feeding the resultant transmission into *one* VHF receiver would be a wonderful substitute if a method for paralleling antenna lines could be found which would not attenuate incoming signals. To avoid the use of matching transformers, et cetera, at the very input of the receiver, the author inadvertently stumbled upon a magnificent breakthrough for the posed problem.

Diversity a la amateur radio is shown schematized in Fig. 1. This diagram, designed for two channel diversity operation, is illustrative of two grounded-grid rf preamplifiers with their respective outputs wired in series for insertion through coaxial cable to the input of the VHF receiver. If built to achieve a very low noise figure, it should exhibit additional gain though the resultant output is lower than it should be due to a lack of sophisticated output, impedance matching networks between the outputs of these two rf preamplifiers and the output jack on the unit in **Fig. 1.**

Standard circuitry is used throughout and,

likewise, standard VHF wiring procedure should be carefully followed. It should be kept in mind that all wiring is to be as short as possible in the critical wiring areas. If operation is desired on frequencies above 220 megacycles, the builder may, of course, resort to standard trough lines as substitutes for the output tuned circuits.

A word on antenna spacing, each antenna, kept as high as possible, should be spaced a minimum of three wavelengths, horizontally; the larger this spacing, the better. Those who are affluent enough to own sufficient land or who reside on a rural (antenna!) farm, will find no difficulty when installing diversity equipment on the 50 megacycle band.

This author, using diversity on the amateur bands, has, also, used the technique successfully on the FM broadcast band, specifically in receiving Jack Parr's WMTW-FM of Mount Washington from the author's QTH. For the serious DX-phile, the proposed method contained herein is inexpensive, easily installed, and most effective in catching DX, particularly when an airplane flies overhead.

. . . WA2MTB

[1]Von Reckinghausen, Daniel, Borish, Martin L., "Space Diversity Techniques Improve FM Reception," *Audio*, p. 48, November, 1960.

Eric Hansen W6HOG
1010 Pine Street
Menlo Park, Calif.

SSB and the National NC-300

I am sure that there are many who have the National NC-300 Receiver and are using it to copy SSB and CW. This receiver has many good features and with very little effort can be made to perform exceptionally well in this mode of operation. There are two shortcomings, both of which will be dealt with in this article. In installing the modifications no holes have to be drilled and the front panel is not destroyed. The complete modification can be performed in less than three hours. The first change was to alter the time constant of the avc circuit. The discharge time was lengthened considerably to provide for smoother operation when receiving CW or SSB transmissions. The avc attack and release times have been set so as to give optimum performance while receiving AM, SSB or CW stations. The product detector and bfo oscillator circuits are modified next. In this change the dc voltage ratios and the signal injection voltage ratios are altered. With this change the action of the product detector is smoother and the amount of distortion is greatly reduced.

Another modification was wired into the receiver which made the unit more desirable for SSB use and can prove to be very useful when in the CW mode. This change is also covered at the end of the article.

1. Remove the cover from the bfo can (T6)

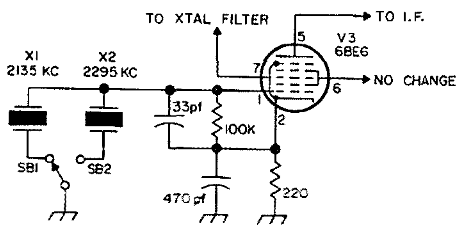


Fig. 1. 2nd converter modifications.

Clip out the 100k resistor (R39) located between terminals B & C and replace cover.

2. Connect a .5 uf @ 50 volt mylar capacitor across R-19 which is located on a terminal strip near L9.
3. Remove R-30 (68k) and replace with a 27k ½ watt resistor. This resistor is located on a terminal strip close to the empty hole by V6.
4. Remove C-55 (5 pf ceramic) and replace with a 5-80 pf trimmer (Arco 463). This capacitor is connected between pin 5 of V6 and an adjacent terminal strip.
5. Remove the wire connected between pin 1 of V8 and terminal C ~~of~~ T6.
6. Connect a 100 ohm resistor from pin 1 of V8 to terminal C of T6.
7. Connect a 220k ½ watt resistor from pin 1 of V8 to ground.
8. Connect a combination of a 330 ohm resistor and a .1 uf 200vdc capacitor from pin 2 of V8 to ground.
9. Remove R40 (68k) connected from pin 5 to pin 6 of V8.
10. Remove C-78 (.047µf) which is connected from pin 6 to V8 to ground and replace with a .02µf 600 vdc paper capacitor.
11. Remove R-54 which is connected between pin 6 of V8 and a terminal strip.
12. Remove R-38 which is connected between pin 7 of V8 and ground.
13. Connect a combination of a 200pf ceramic capacitor and a 10k ½ watt resistor from pin 7 of V8 to ground.
14. Solder a 2-lug terminal strip to the case of the output transformer (T2) located near V8. Place the strip on the side nearest V8.
15. Connect a 100k ½ watt resistor from pin 5 of V8 to one of the insulated lugs on the

terminal strip just installed.

16. Connect a 56k ½ watt resistor from the lug on the terminal strip with the 100k resistor just connected to it, to the other insulated lug on the terminal strip.
17. Connect a 10k ½ watt resistor from the lug with the 56k resistor only on it to pin 6 of V8.
18. Connect a wire from the junction of the 56k and 100k resistors to pin 6 of V10 (6AQ5). Replace C-41 (.01) with .22μf at 35v.
19. Turn the receiver on with the rf gain fully clockwise and the mode switch in the AM position. The calibrator is then turned on. Tune in the calibrator for maximum deflection of the "S" meter. Place the mode switch in SSB and rotate L6 until the beat note is zero-beat. This operation sets the bfo in the proper position on the *if* slope.
20. With the receiver in the SSB mode of operation and the rf gain fully clockwise, adjust the variable trimmer on V6 from minimum capacity up to the point where distortion is heard while receiving a strong SSB or CW station. Back the capacitor off about one-half turn and leave at this setting.

This completes the wiring changes dealing with the product detector, CWO oscillator, and AVC circuits. The receiver *if* stage should be aligned for optimum performance as some of the components that were changed will tend to load the *if* strip differently than before. If the following selectable sideband modification is going to be installed do not realign the receiver at this time as this will be necessary after the sideband change also. Whether the receiver is aligned or not the trimmer capacitor in step 20 will have to be set as this sets the level of the signal fed from the *if* strip to the detector. The receiver should be placed in the SSB mode when receiving CW or SSB stations because in this position only is the avc employed. If it is desired to eliminate the avc action when receiving a station the mode switch should be placed in the CW position. The "S" meter will become more "bourbon" and will read much higher than before. By retarding the rf gain control one-quarter turn, the meter will read correctly.

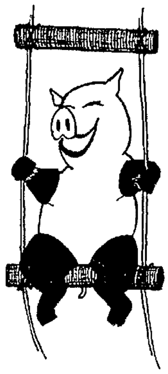
Selectable sideband modification

Following is the modification for installing a switch in the NC-300 in order to provide for upper and lower sideband selection without touching the CWO control. This is accomplished thru the addition of two crystals, one on each side of the *if* bandpass

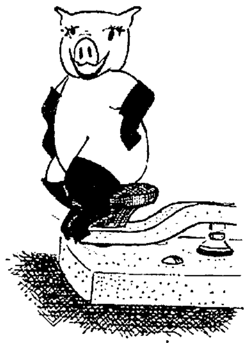
1. Remove the wires from the phone jack on the front panel and connect the blue and green wires together. Do not remove the black wire from the xmt-rec switch. If desired, the phone jack may be mounted on the rear of the chassis and re-connected so the front panel will not be disturbed. Remove the phone jack from the front panel.
2. Install a spdt rotary switch in the hole where the phone jack was removed. If a rotary type switch is used, the hole will not have to be enlarged.
3. Disconnect the wires connecting T5 to the rest of the circuits.
4. Remove T5 and replace with a plate upon which are mounted 2 crystal sockets which will hold crystals XI and X2.
5. Remove R9 which is connected to pin 1 to V3.
6. Remove the wire connected to pin 2 of V3.
7. Connect a combination of a 33pf capacitor and a 100k ½ watt resistor from pin 1 to pin 2 of V3.
8. Connect a combination of a 220 ohm ½ watt resistor and a 470pf capacitor from pin 2 of V3 to ground.
9. Connect a wire from pin 1 of V3 to one end of each of the two crystal sockets.
10. Connect the common terminal of the spdt switch installed earlier to the black wire, the other end of which is connected to the xmt-rec switch.
11. Connect one of the switched terminals of the spdt switch to one of the crystal sockets.
12. Connect the other terminal of the switch to the remaining crystal socket.

The wiring changes required to provide for selectable sideband are complete. In most receivers it will be found that the correct setting for the CWO control is half-way between the center and the position marked "2". The *if* strip in the receiver should be peaked up due to the fact that the crystals will be on a slightly different frequency than the coil network that was removed. The 2295 kc crystal will provide lower sideband on 80 and 40 meters and upper sideband on 20,15 and 10 meters. The 2135 kc crystal will provide upper sideband on 80 and 40 with lower sideband on 20,15 and 10 meters.

This completes a series of modifications that I believe you too will agree makes the National NC-300 a real fine-business single sideband receiver. . . . W6HOG



Wayne Pierce
K3SUK



This jovial fellow with a twinkle in his eyes is Wayne Pierce, K3SUK, the artist responsible for this month's cover, "Little Annie Hammy," "Ham Word Play," and most of the cartoons and other artwork in this issue. Wayne is well known to 73 readers. His first 73 cover was November 1962 and he's done many more since then, including the January 1964 Callbook spoof, the October 1964 cover and lead article, "A Ham in the White House?", and the February 1965 TVI cover. He's also provided clever illustrations for many articles, excellent cartoons and an occasional piece of art.

Wayne has been a junior high school art teacher in his hometown of Oxford, Pennsylvania since graduating from Kutztown (Pa.) State College in 1959. He's married and has a two-year old son.

Most of Wayne's ham operating activities are confined at present to CW on eighty and forty meters with some six meter phone work in the Chester County RACES for the local civil defense.

He's also a sports car and putters around with his MG TF-1500 when the weather cooperates.

NEWS FROM THE INSTITUTE OF AMATEUR RADIO

Compiled by A. David Middelton W7ZC, Secretary

Basic structure of IoAR

The basic element of IoAR is its Members who may be either licensed Amateurs or persons seriously interested in Amateur Radio.

There is only one class of Member. All Members may vote. There is a special reduced STUDENT membership rate for those who have not yet reached their 20th birthday.

Only *licensed* Amateurs may hold office in IoAR and all officials must be members of IoAR. Nominees for any office must have held an Amateur license for 18 consecutive months and have been a member of IoAR for 6 consecutive months prior to the date of nomination.

All Members will be polled on all matters of importance concerning IoAR and Amateur Radio. The majority vote of the Members will determine IoAR policy. Members have the right to amend the Constitution and By Laws.

IoAR regulations provide for both local CHAPTERS and AFFILIATED CLUBS. Both must meet certain simple requirements as to membership in IoAR.

Regulations provide for IoAR Field Organizations, under the administration of the Secretary, to be comprised of REGIONAL, STATE and AREA officials who assist HQ in coordinating the activities of Members residing in their respective geographical areas.

The IoAR is governed by a Board elected by Members. This Board consists of not less than five Directors (to be elected in '66, two more to be added in '67 and in '68, bringing the total to nine) a Secretary and a Treasurer. The latter two have no vote on the Board. An executive Committee to handle day-to-day IoAR problems (not policies) consists of the Secretary and not less than two directors. All have a vote.

The Board will select one of its members to be its Chairman for one year, the post charging each year. Directors may serve no more than two full consecutive terms of three years in the same office.

There is NO work-affiliation restriction placed on IoAR Directors or other officials. IoAR *welcomes* in its elected officers the skills, talents and demonstrated ability available only in the vast pool of technologically-trained licensed Amateurs directly connected with the electronics industry at all levels.

Pasadena IoAR member fights GI Blues

One amateur, (a veteran of the Armed Forces) fed up with "draft-card burning" and beatnick picketting, decided to DO something to make Christmas brighter for those many GIs stationed far from home and family.

A. E. O'Brien, WA6YZN, of Pasadena, secured the cooperation of the business men in the Foothill Rosemead Shopping Center and set up a ham station in the office of his brother's travel agency.

Message blanks were made up and distributed to all merchants in the Center. Daily collection of messages was made and through the cooperatoin of the Mc Can 7, the Mc Can 4 and the Mission Trail nets traffic was cleared to all parts of the world. Other nets also participated in this Christmas message operation.

OB's traffic report for the holidays follows—538 messages originated at WA6YZN—all on official message blanks with complete address of sender and addressee.

147 messages relayed by WA6YZN from other nets.

40% of all traffic was to Armed Forces.

Many overseas GI phone patches were made but not included in the totals above.

Continuous operation from 0530 Dec. 23 to 1830 Dec. 25th by OB himself!

The equipment used was a SR500, the very same piece of equipment used by Scott Carpenter in Project SEA LAB off La Jolla.

IoAR congratulates WA6YZN for his one-man effort that brought much happiness to lonely GIs and their families at Christmas.

Congressman replies to IoAR news letter

In January IoAR HQ transmitted its first *news letter* to the Senators, Congressmen and other governmental officials. This letter format was sent via First Class mail, in the desire to obtain greater reader interest and attention by the recipients. Previous releases (in card format) drew many favorable comments from key personnel in Washington's legislative circles.

Here is a direct reply to our January letter.
Secretary, IoAR—

This will acknowledge and thank you for the December issue of your "Amateur Radio around the USA and Across Borders".

I have long been an admirer of the very useful

IoAR—Totally Dedicated to the Betterment and Preservation of Amateur Radio.

function of amatuer radio operators and add my compliments for the many humanitarian deeds your members perform.

With best wishes, I remain

Sincerely yours,

Febr. 2, 1966. s/James F. Battin,
Member of Congress
2nd. District, Montana

Building-writing contest for young members

The "News from the IoAR" column in March 73 carried full details on the first IoAR-Member competition involving the building and article preparation of electronic gear.

This competition is solely for IoAR Members who were born after July 15, 1946. If you are in this age bracket you are invited to construct an original piece of equipment, write an article describing it and submit it to IoAR HQ where it will be judged.

A total of three prizes will be awarded. 73-space rates will be paid the author/winner in each of three categories; equipment having more than 5 transistors or tubes, an item having more than 3 transistors or tubes, and one having less than 3 transistors or tubes.

See "News from the IoAR" column in 73 for March 1966. If a copy is unavailable, send SASE to IoAR HQ for reprint of the News.

Amateur radio in experimental satellite

With the successful operation of the amateur built equipment aboard OSCAR 4 designed and built by the TRW Systems Radio Club—(see February 73 page 110) it is gratifying to see still another entry into the Amateur satellite field.

ARIES is the name of this latest effort on the part of organized Amateur Radio to build satellites!

The following is a quote from a comprehensive technical and news bulletin from the ARIES group— "It is the desire of the San Fernando Valley Radio Club (SFVRC) that ARIES, acting in the manner of its namesake, aid in the exploration of space communications as its predecessor, a now extinct star, aided the ancient mariner in his quest for knowledge of his environment.

"The pioneers of the OSCAR program have blazed a trail for the American Radio Amateur in the realm of space communications. Consistant satellite communications still require "better than average" equipment, and state-of-the-art techniques. What is needed now is a concerted effort on the part of many amateurs pooling their talents to develop both equipment and techniques for the exploitation of this new means of communication."

QTH? Lost members! Where are you?

IoAR HQ needs the correct up-dated QTH for the following Members:

Carr, Clarence R., K9HUK.
Ritter, David L., WA6KXE.

Important IoAR Addresses

For all correspondence except that regarding membership and supplies:
Institute of Amateur Radio
Springdale, Utah 84767

For membership correspondence and IoAR supplies:
Institute of Amateur Radio
Peterborough, N.H. 03458

Prominent Amateurs join IoAR

Among the steadily increasing number of Amateurs joining IoAR is Senor Luis Salido, XE2IL, of Navojoa, Sonora. Luis, one of the most active participants in organized Amateur Radio in Mexico, is a "prime-mover" in Liga Mexicana de Radio-experimentadores, Red Nacional de Radio Asistencia and Club de Radio Experimentadores de Sonora. IoAR welcomes XE2IL, a neighbor from south of the border!

Another internationally-known Amateur also became an IoAR Member when Mr. John Gayer, HB9AEQ, of Geneva, Switzerland, founder and past president of the International Amateur Radio Club joined us and will carry first hand knowledge of IoAR back to Geneva with him.

Mr. Gayer now supports IoAR's efforts as many IoAR Members have long done for IARC!

INSTITUTE OF AMATEUR RADIO MEMBERSHIP APPLICATION

(Use separate sheet if desired)

Name .... Call ....

City .... State .... Zip ....

....$5 for 1 yr. IoAR Membership.

....$2.50 for 1 yr. IoAR Student Member.

....$7.00 for 1 yr. IoAR Mem. plus 1 yr. 73.

....$4.50 for 1 yr. IoAR Student Mem. plus 1 yr. 73.

....I am a new Member of IoAR. Age .....

....I am a Charter IoAR Member and desire to have my membership continuous.

....This is a renewal of 73 but a NEW IoAR Membership.

Please send check or money order (cash sent at sender's risk) to:

Institute of Amateur Radio, Inc.
Membership Department
Peterborough, New Hamp. 03458

Adam Leller K9SGZ
Valpariso Technical Institute
Valpariso, Indiana

Multi-Channel Transistored Pre-Amp

This article will describe a transistorized version of a pre-amp which was offered by W9CWG in an early issue of 73. Since that article was published, several people have written to Wig requesting such a unit, so one was thrown together in a few spare moments. The unit uses inexpensive 2N404 (or 2N3628) transistors, but other types may be substituted without too much bother. Almost any PNP audio or switching transistor will work fine, with only minor changes in biasing required.

The circuit starts off with a cascaded emitter follower input, using negative feedback through C_1 to raise the input impedance to such a level as to allow the use of a crystal microphone. This circuit will have about .5 megohm input impedance at 1000 cps, depending on the beta of the transistors used. Following the input stages, the signal passes through a common emitter amplifier which will have about 20 to 30 db gain, depending on how many output stages are used. If it is noted that the circuit has more gain than is required in an individual application, the capacitor C_2 may be omitted, which will reduce the gain to about 10 db. If this is still too much gain, all of the circuit between the points marked "X" may be omitted, which will give about 2 or 3 db overall *loss* from input to output. Following this amplifier stage, the output is coupled through emitter followers to individual output gain controls. These outputs will allow use of low impedance loads, such as 500 ohm inputs to commercial Two-Way equipment.

The unit I built is wired on a masonite board about 4 by 6 inches. Circuit layout is not critical, but the completed amplifier should be housed in an enclosed box to prevent rf problems. If rf problems are encountered, an rf choke in series with the input lead, connected right at the base of the input transistor Q_1, along with about a .001 µf capacitor from Q_1 base to ground should cure the problem. Once the circuit layout is determined, holes may be drilled in the board (with an ice-pick, if no drill is available) to mount the components and the circuit wired on the back of the board using point-to-point (haywire) wiring techniques. Keep all leads very short around Q_1 and the input circuitry and no problems, hardly at all, should be encountered. A hint here, if battery power is to be used switch the battery on and off with an unused set of contacts on the antenna relay or such. This will save the battery and since the unit does not require a warm-up time will offer no problems, other than perhaps the need for an rf bypass capacitor on the supply voltage line inside the enclosure for the pre-amp.

All components are standard parts, and are not critical. Just empty the junk box and you should have enough parts to throw together this little gadget. It may be used on a 6 or 12 volt automobile battery system with no circuit modifications, so should lend itself nicely to mobile applications using converted two-way FM equipment. . . . K9SGZ

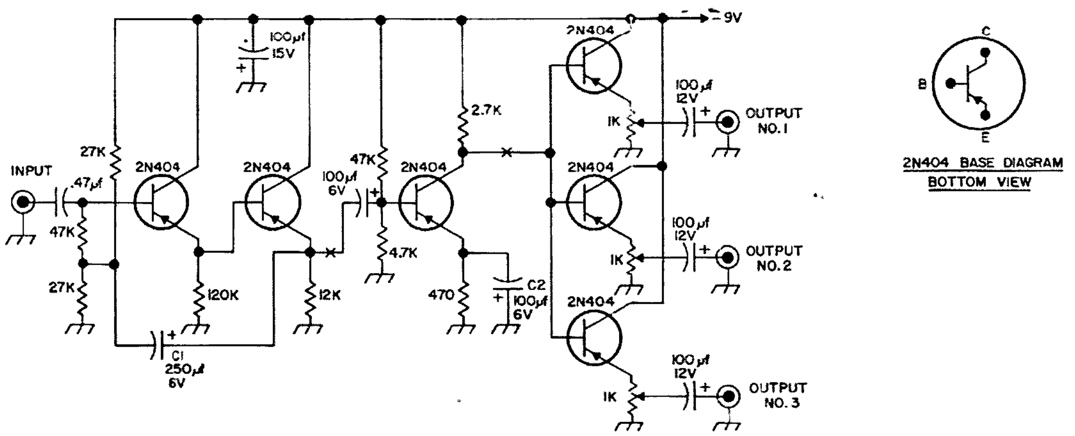
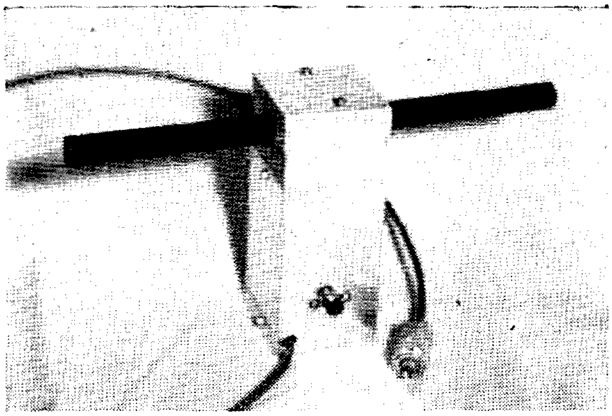


Fig. 1. Three channel output transistorized pre-amp. A good transistor to use in place of the 2N404 is the silicon 2N3638, a 2N404 replacement at the same low price (less than 50¢).

Walt Rogers W1DFS
24 Orient Avenue
Melrose, Mass.

Ferrite DF



The Ferrite DF built into a Minibox.

Radio aids to navigation, or radio D-F as they are more commonly known, have been in use for marine and air operations for a number of years. The needs and techniques of these services are much more sophisticated than necessary, for the amateur to benefit from the principles of radio D-F. However, very little has appeared in amateur magazines lately in the way of a simple unit that we all could use.

Briefly, direction finding (D-F) depends upon the use of the directional characteristics of the antenna. In order to establish a fix, or point, it is necessary to have two bearings. While a sensing antenna giving only one direction would be handy, the balancing and maintenance of signal conditions at the D-F installation must be unmodified after a balance calibration. Also a single direction will not give the distance, so as to get a firm fix. Thus for the sake of simplicity in use, only the bi-directional design is presented here.

The unit to be described, using a ferrite antenna, has less output than others, but is a far more convenient package. Less signal is secured from the ferrite antenna primarily due to its limited size as compared to a normal half-wave antenna at these frequencies. The efficiency is up, however, when it is tuned to resonance. Most receivers have enough spare sensitivity so that the strong signals can be received very well and many of the weaker signals well enough to get good readings.

Construction of the unit is quite straightforward and one should have no trouble duplicating it. The Ferrite D-F is made from a tuned ferrite rod, tightly coupled to a short piece of coaxial cable which goes to the receiver. This tight coupling to the coaxial feedline is necessary in order to obtain maximum signal transfer. The rod is a much more effective core material than air and therefore fewer turns are needed on it. The number of turns listed in **Fig. 1** are for the ferrite rod. A grid-dip meter would be a help in determining that resonance can be obtained over the 75/80 meter band before completing the assembly. A small aluminum box was used to minimize hand effects and provide a convenient mounting. The wood pieces were made to clear the turns on the coil and with a few turns of plastic tape fit tightly on the rod.

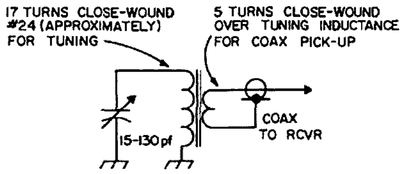


Fig. 1. Schematic of the Ferrite DF. Core of the coil, naturally enough, is a ferrite rod.

In operation plan to run the rf gain on full and after locating a signal and turn the rod broadside to secure the sharpest null. The D-F tuning capacitor should be set for maximum signal. To aid in obtaining the fix it is a good idea to establish which way is true North. Remember, magnetic North is usually not true North and a declination correction must be made. All good maps give this correction, but better still, take a look at the North Star in relation to the radio shack's orientation and use this as a bearing reference at home. Get a bearing from another station and mark a line from his location and one from yours—where they cross, that is the fix.

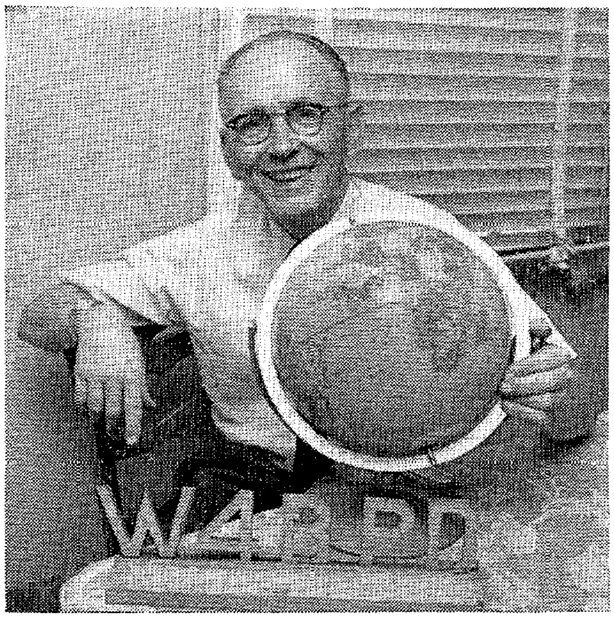
On mobile work it is suggested that road maps be used. After getting a reading drive approximately perpendicular to this line (roads permitting) and after a while take another reading. The crossing of these lines is the fix. For close up readings a modified field strength meter with a sensitivity control could be used, but this is another story.

The next time you become annoyed at a dead carrier or some other form of interference on the band get out the Ferrite D-F and with the aid of a few fellow hams hunt it down. At the next meeting of your radio club suggest a hidden transmitter hunt to the Activities Chairman if you want some real fun.

. . . W1DFS

Gus Browning W4BPD

Gus: Part XI



Last month I stopped when Rundy was getting ready to move on to Qatar, just up the Persian Gulf from Bahrein Island. We had our licenses all in order for all the MP-4s all the way up to and including Muscat. We had all our police permits in order and our airline tickets in our pockets. We had been in Bahrein about 6 or 7 days and had made many thousands of QSO's. As I mentioned in last month's article we stayed in the only hotel there, the Speedbird Hotel, and boys, if you want to be sure you have a place to stay when you go to Bahrein I strongly suggest that you make reservations well in advance. Lord knows where you will stay if you get into Bahrein and cannot get into this hotel. You know you are right in the middle of Moslem country there so pork is taboo. One of the bell hops there told me about some British sailors who stopped there a few days. These fellows ordered pork chops at the Speedbird and quite naturally they were told that there was no such item to be had. Well these fellows went back to their ship and got some pork chops from the freezer and brought them to the hotel and went back into the kitchen and gave them to a cook and told him to cook them. This cook was a little young and not too experienced with the fact that this was pork when in the middle of frying them the head cook came in. He sniffed around and his nose told him there was pork in that frying pan. He made the young cook remove the pan from the stove, take it out in the yard and bury it, chops and all. Then this young cook was fired on the spot!

The little planes that fly up and down the Persian Gulf are some sort of small four motor jobs. I am not sure just what kind of plane it actually is but it seems like it was a DeHaviland. Down to the airport we went and we were off to Qatar. When you take off from Bahrein that's when you can see all those oil derricks. It looked like I was over Texas with the exception that there was desert all over the place. Millions of years ago there must have been something other than deserts there to put all that oil under the ground. They tell me it usually rains about once during the year, but boy with all that oil under the ground who needs rain! The plane hugged the coast and in a very short while we landed at Qatar. Rundy told the taxi driver to take us to the hotel. At that time there was only one there and boy it was an eye-opener! I've forgotten its name but it looked like one of those Hilton jobs, real fancy, completely air conditioned, and about $22.00 per day. We checked in and set up our antenna. This was very easy. We just ran it from the top of the hotel down to a fence post in the direction of the big swimming pool. Just a few hundred feet from the pool was the Persian Gulf, very blue and calm looking. We saw a number of Arabian dhows with their very odd shaped sails going up and down the Gulf very slowly. The seamen on the dhows were a tough looking lot and truthfully I would not make a trip on one of those things. I would be afraid that I would never get to the place I was headed for.

We loaded the antenna up to the rig and the first CQ was sent out from MP4QAR and boy, business was FB too. You know things usually go like this when you first set up and start operating from a relatively rare spot. You call that first CQ and maybe one station

comes back to you. Then sometimes you have to call another CQ to get the boys going. Well that time only one came back but when you sign with him that's when things began to pick up. By that time maybe 6 or 8 fellows are on your trail, and when you sign these 6 or 8 calls about 50 other fellows hear them and most of them join in even if, up to then, they have not even heard you. That's when you start having trouble picking one out of the pile. Now boys, don't fool yourself that there is always one fellow who is louder than everyone else in the pile—this is just not so. Nearly all the time everyone is at least within one S point of each other. The fellow you work is the fellow in a clear frequency, not the fellow who is slightly louder than the pack. So boys I strongly suggest when you are trying to work a rare one pick yourself a clear frequency, do some very close listening first, then jump in with a De-W??? about 3 times and BK. That's the way the smart boys operate.

Some of the fellows have a sort of trade mark—W3CXX just sends XX XX XX, DL7AA sends Gus Gus Gus, W6SC, when on SSB, sends South Carolina, South Carolina, and about one of the best of all is W4CCB who just sends Coca Cola bottle. If you can think of a good trade mark start using it and if it clicks, stick with it from then on. I am trying to come up with a good one for me to use when I get started again back at W4BPD but so far I am stuck—how about some suggestions, boys!

Incidentally, I am writing this portion of my story while I am in the Central Hotel in Ouagadougou (pronounced Waggadou-gu) Upper Volta. The rates here for a single air Ouagadougou (pronounced Waggadou–gu) is about 8 or 9 dollars. Coca Cola here is 40 cents per bottle, a good dinner is over $4.50, breakfast with only one egg and a small piece of bacon and a cup of this very black, very strong coffee is about $1.50. You don't live here cheap unless you can live on bananas and oranges. Another thing I have found is that you just don't hop on a plane here anytime you want to go. You have to wait, and I mean sometimes one full week to get a plane that will take you some place you might want to go. This is a bad place to be stuck, too. For two cents I would connect up the rig and do some bootlegging right here but then there are these red caps who probably would broadcast this news to the wrong people and you would be in dutch with a capital D!

Oh yes, the YLs here wear these topless dresses, not all of them, but a pretty good number. I hardly pay any attention to these things any more. I wonder if the topless bathing suits ever really became the style over in the USA would such things ever go unnoticed. I, for one, think they should try it out and see. I have been thinking a lot lately what it is I miss most being away from the USA. Of course number one is being with Peggy and seeing my own children and those five little grandchildren (it's five in 1965, maybe later on there will be more of them). The next biggest thing I miss is getting a nice slice of good white, soft bread and a big cold glass of milk, those good tomato sandwiches my wife makes covered with mayonnaise, real southern fried chicken, someone I can talk to (it's 99.9999% French here) seeing my favorite TV program, operating a big ham station with a big beam and seeing all my friends. Those are the kind of things you miss most of all when you are away from home as long as I have been.

Well as usual, I completely wandered off the subject. Rundy and I were operating at the real fancy, air conditioned hotel in Qatar and we had a ball the first few hours. We went down and had our lunch and back we came to the rig. It was going like blazes when there was a loud knock on the door. Yes, you guessed it, it was the police. There they were, all three of them, wanting to know what we were doing with all that radio equipment all set up and operating. Rundy produced our licenses and told them we were permitted to operate in Qatar or any of the other Persian Gulf countries. After a while they more or less agreed with him but in the end it seems like we both had to go down and check in with the police and explain again to them just what we were doing there, how long we would be there, and all the information on our equipment. We all shook hands and we returned to our room. From then on we had no more police trouble while we were in Qatar. Boys, see the local police *first* because if you don't they will be seeing you!

Rundy and I packed up and away we went to the Trucial States. The plane landed at Shariah where one of Rundy's friends met us. We decided that since every operation up to that time had been from Sharjah that we would go to the Shiekdom of Dubai some 30 miles away from Sharjah thinking maybe somehow it would count for a new one if ARRL could ever be convinced as to just how these shiekdoms were governed. As for Rundy and me, we both still think that each of the seven should be different countries. There was sort of an outline of a road there, but it was very vague in spots and almost disappeared at others. But we did find Dubai all OK. It

was a real Arabian settlement. I think it used to have a hotel there but I guess the hotel business sort of disappeared. The building that was once a hotel was almost deserted. The two top floors were completely empty and all the rooms were bare to the wall. A friend of Rundy's owned the building and gave Rundy and me permission to move in any of the top floors. We picked out a nice large room on the top (fifth) floor and the owner of the hotel loaned us two cots and the bed clothes. Most of these Arabic buildings in and around that part of the world have a flat cement roof. This one was like that with an added cement fence around the edges of the floor. This proved to be a fine spot to install an antenna. We rounded up four nice long bamboo poles about 40 feet long and got them up on the roof, and while Rundy was looking up a friend to borrow an extension cord from, I was left to put up the antenna. We had secured the assistance of a young Arab fellow about 18 years old and he would hold up the poles while I would fasten the guy wires to the cement rails around the roof. We were up there working up a storm in that hot blazing sun about 3 PM when the PA system on one of the nearby mosques cut loose with that long wailing call to prayer for the Moslems. This fellow who was helping me asked me to hold the pole a few minutes and he whipped off a prayer rug that was over his shoulders all the time.

He spread it out quickly on the roof, faced Mecca and did his praying. I wonder just how close they are when they think they are facing Mecca. Maybe someday I will get some cheap compass manufacturing company to make me some compasses, each one of course calibrated for four different countries that has no north on them but Mecca instead. Perhaps I could pick up a few hundred bucks like that. I would have some real fancy ones made up for the shieks and some extra large ones for the mosques built in the floor, and perhaps even hand calibrated ones if someone wanted to be exact.

Conditions were wonderful in Dubai all the time. Up to about 2 AM the bands were wide open to almost everywhere. They would open again about 5:30 AM. By about 10 AM they were just about flat—and that's when we slept. Rundy rambled out one day to locate and pay his respects to the local shiek. I was on the air yakking to someone a few hours after Rundy had left and believe it or not Rundy broke in with a "Hello Gus," with some sort of a MP4T call sign. I said where in the world are you? He said he was out at the shieks. Then he told me that the shiek had a SSB rig so he could talk to the other shieks.

It looked to me as if everyone eyed us with suspicion every time we went down the street, but after a while I figured that this was their normal look. I often wonder if they ever trusted even each other—I kind of doubt it myself. I did not see what they call 'European toilets' anyplace there. All they had were what they call 'Arabic toilets'—a place outlined for your feet to be placed and just a hole in the cement, a water spigot nearby and usually a small worn piece of cloth hanging on the spigot. Oh yes, remember—your left hand—and that's the hand I usually eat with.

I saw many people, usually the older ones, on the street smoking their hubbly bubbly. That's those pipes where the smoke goes through the water and sort of goes blubb blubb everytime you take a draw on it. I even tried taking a few puffs myself just to show the people I was a regular fellow. I even found some Cokes there too, never quite cold, but they sure did come in handy with that hot weather.

I went all over the town of Dubai and I tried my best to figure how these people made a living. There were only a few trees here and there, no large groves of trees indicating that olives, dates, oranges, etc. were being grown, at least not for market. A few Arabian dhows were being built down at the docks, a camel caravan or two came in each day from across the desert, one small ship docked and stayed over night. That was it! Rundy and I were treated very well while we were there and I hope some day to return and see more of this very intriguing part of the world.

We drove back to Sharjah in the Jeep over the desert and departed for Kuwait. Arriving there one of Rundy's representatives met us at the airport then took us to his house—a real nice Arabic type with the big high cement wall all around it. We never heard or saw any females while we were there. It seems as if the house was divided in the middle and all the females stayed in the other side, which must have been soundproofed because I never heard any sounds from there.

While the plane was coming in to Kuwait I saw more doggone oil wells than I have ever seen in my life. The desert seemed to be covered with them. We tried our best to get a license to operate from Kuwait but there was no possibility of this because we heard that someone from Kuwait was in the USA and tried to get a license and he was refused. When this fellow returned to Kuwait there was an American who was operating there and his license was cancelled immediately and he was told he had 48 hours to dispose of his

radio equipment! Just what ever happened to his equipment I have never heard. Mind you this man had been in Kuwait something like 10 years. I understand the present status of Americans there has somewhat improved and it may be possible now to get a license.

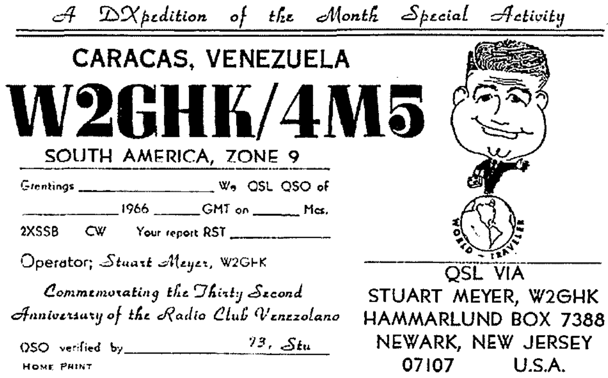
Every day I would go out for a walk and I noticed an old fellow who was always sitting at a little sidewalk cafe smoking his hubbly bubbly. He would smile at me and I would smile at him. One day I had my camera with me and I walked up to him and by hand motions asked him if it was OK to take his picture. He smiled and nodded. When I had put my camera back in its case, he motioned me to have a seat and out came a cup of that awful strong Arabic coffee for me. Well, to be sociable I drank it in small sips and when I had finished he offered me the stem of his pipe for a few puffs, which is what I did. This delighted him. He saw I was one of the boys, I guess. He spoke not one word of English and quite naturally I spoke no Arabic. But we did become good friends somehow or other. The next day when I passed him he motioned for me to have a seat at his table and out came a Coca Cola! I tried to tell him the last day I passed him, after drinking his Coke, that tomorrow I was leaving for the USA. I had no

idea that he understood me at all. The next morning I passed him on my way to the airline offices to inquire about whether they had a bus or not and he handed me a carton of Kent cigarettes as a going away gift. I never did spend one single cent on this man. He was just a good friend and wanted to show me that he was sincere. I have found that a big smile goes a long way anywhere in the world, a pay on the back and other ways of showing that you are a friend sure does pay off almost everywhere.

After spending one or two nights with Rundy and drinking his Cokes I departed for Rome where I was going to pick up my deposit that I had put down when I entered Italy from Monaco. Boy, it was the usual run around and I could see that I was going to have to spend three or four days or more trying to get my money. At 11:45 AM I was sitting up in my hotel room trying to figure out what to do. I phoned TWA and asked about a seat on the next flight to New York City (this was Dec. 23rd!). They informed me there were no seats until after the 1st of January! I did a lot of fast telephoning in the next 10 minutes. All flights to NYC were fully booked. The last phone call to Pan-Am was the same, but apparently someone had cancelled a few minutes earlier and they said if I could be at the airport in 45 minutes I could have that one seat. Here I was with a TWA ticket, so I quickly loaded all my junk into a taxi and away I went to TWA to get them to initial my ticket over to Pan-Am. This involved a long drive across Rome to their office and away we went for the airport which is located about 20 miles from the city. This was a fast trip let me tell you. The taxi driver could speak English so I told him 'double fare' if he got me to the airport in time. He got me there exactly at departure time for the plane. I ran out on the apron where the 707 was getting ready to leave. They had already pulled the ramp away from the plane. I hollered "wait a minute" and they pushed the ramp back in place. I arrived in New York about 7:30 and was in Columbia, South Carolina by 10:30 that same night. Peggy still had her TV-radio shop open and when I walked in the first thing she said to me was "I was not expecting you until sometime in January!" This was the end of DXpedition number one. I was back home, safe and sound and I think a lot wiser than when I had left there about 8 months earlier. I had lost about seven pounds, had a little suntan left from the Persian Gulf sunshine, most of my clothes were pretty well worn out also. It was nice to be back home with all my family again. I had taken a few thousand color slides and quite a number of rolls of 8 mm color movies. The news got around and a number of service clubs wanted me to come to their meetings and give a talk on my DXpedition. Many people came out to our house to see some of the items I had picked up here and there. Those carvings from Africa was usually the center of attraction. The usual talk of another DXpedition made the rounds and everyone wanted to know when I was going on the next trip.

On my first trip I had made up my mind that I would never, under any circumstances, black ball anyone, regardless of how rotten they were. I would work everyone I heard regardless of what country they were in. I would operate as near as possible around the clock, not just when the W's were coming through. I would never use this W1, W2, W3, etc., business. I would never have a list of certain stations to work in preference to others even if they were good contributors. I would send no QSL cards direct to anyone. I would try to improve my operating habits and stay on one certain exact frequency all the time. I would give signal reports nothing else and try to work as many as possible in every place I operated. Also, I would try never to get mad at anyone at anytime!

Well that's it boys. This concludes DXpedition number one. I will start on trip number two next month.



Caracas convention

If you are one of the fellows who missed attending the International DX Convention and the 32nd anniversary celebration of the Venezuela Radio Club, you missed one of the finest gettogethers I have ever had the pleasure of attending. For about 10 days and nights it was one continuous round of celebrations, meetings, eye-ball QSOs, party gatherings, drinking and hamming.

The Venezuela Radio Club will have one of

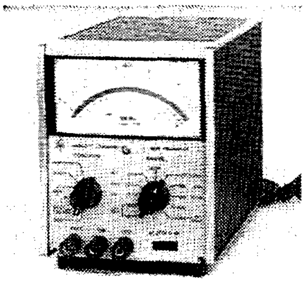
these every year from now on. I suppose it will be the week-end after the Miami Hamboree which is usually near the last week-end in January. The air fare from Miami to Caracas and return was only $199.00. Why not plan to make both the Miami and Venezuelan Conventions next year. Take off a full month from the cold Yankee weather, go swimming, hiking, meet the world's friendliest batch of hams and come back home with a sun tan.

You like to see FB antennas? Well this is one spot where everyone has a beam—3 elements, 4, 5, etc. Equipment—every station I saw was loaded with the very best. There were no hay-wire outfits down there. These fellows are the most serious batch of DXers I have ever met. When they go after DX it's no holds barred. But they are real gentlemen and when one of them is in QSO with DX the others stand by and let him finish. This cooperation is necessary as Caracas is in a valley almost completely surrounded by mountains.

I think I can speak for everyone that attended the convention when I say "Peggy and I had the best doggoned time we have EVER had at any ham gathering"—and this covers a lot of territory. We both send the YV boys our many, many thanks.

. . . Gus

NEW PRODUCTS



H-P AC/DC VOM

If you need a volt-ohmmeter better than most of those available to hams, the new Hewlett-Packard Model 427A might be of interest to you. It's an AC/DC voltmeter with 2% full-scale accuracy. The 427A is all solid state and operates off a single 22.5 battery, or from the AC line. It is priced at $195.00 and more information is available from H-P, 1501 Page Mill Road, Palo Alto, California 94304.

Semiconductor Chart

Semitronics has just brought out a Semiconductor Interchangeability and Replacement Guide in the form of a two color, 22"x26½" wall chart that's just what you need to cover up that big blank space above your transistor work bench. It will give you all sorts of useful information. You can get a free copy from your Semitronics dealer, or one for 25¢ from Semitronics, 265 Canal Street, New York, N.Y.

Ionospheric Radio Propagation

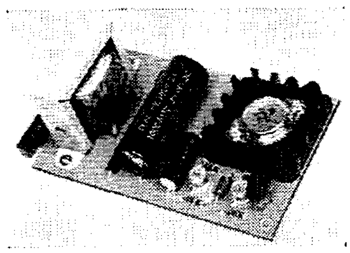
This book by the chief of the Ionospheric Research Section of the NBS is just what every ham interested in propagation needs. In addition to the traditional areas that are covered, *Ionospheric Radio Propagation* includes two new chapters, one on VHF and one on LF and VLF propagation. The book is 470 pages, illustrated, and available for only $2.75 from the Government Printing Office, Washington, D. C. 20402.

New Meshna Catalog

John Meshna makes one of the most interesting surplus catalogs around. His latest one is about 85 pages and contains pictures and descriptions of a fantastic amount of surplus gear. Even if you don't buy anything from him (which is unlikely after you've spent a number of hours reading the catalog), you'll find it worthwhile to send 20¢ for a copy. Meshna, 19 Allerton Street, Lynn, Mass.

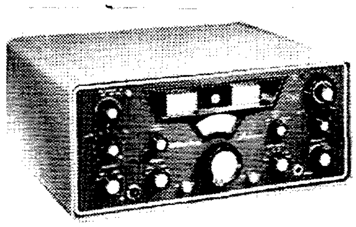
Lafayette Two Band FM Receiver

One of the few FM monitor receivers that covers both the low and high FM bands is the inexpensive Lafayette HA-520. It uses a Nuvistor rf stage, tuned rf amplifiers, squelch, slide rule dial, ten tubes, etc. Price is $89.95 from Lafayette, 111 Jericho Turnpike, Syosset, L.I., N.Y. 11791.



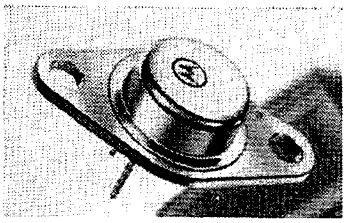
ESSCO Regulated Power Supply

ESSCO, who makes a line of real nice solid state RTTY equipment, has just introduced a low cost regulated solid state power supply, the PS-3. It provides 6 to 12 volts DC at up to 500 ma with 3% regulation and .05% ripple or less. The PS-3 is perfect for transistorized VFO's, transmitters, converters, RTTY equipment, etc. Size is 3"x5". The PS-3 is $26.95 and a kit version, the PS-3K, is $16.95. ESSCO, 324 Arch Street, Camden, N.J. 08102.



Hallicrafters Hurricane

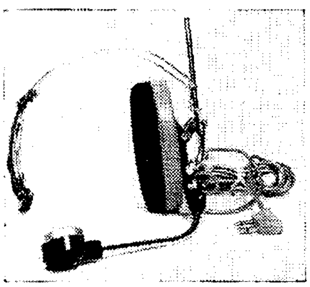
2000 watts PEP SSB is what you get with the Hallicrafters Hurricane SR-2000 five band transceiver. I guess that's about all the power you're likely to need in a transceiver and the Hurricane offers a lot more besides: low distortion, high sensitivity, receiver incremental control, AALC, 1 kc calibration, *if* noise blanketing, etc. Yet price is only $995.00. A companion power supply/speaker, the P-2000AC is $395.00. You can get more information on the Hurricane from your dealer or from Hallicrafters, Fifth and Kostner Avenues, Chicago.



Motorola Transistors

Motorola has just reduced prices on their rf transistors up to 91% and now they're up to more mischief. This time they've brought out some silicon high voltage transistors perfect for voltage regulators, audio amplifiers, high voltage converters, line relays, CRT drivers modulators, etc., all using regular AC line voltages. Maximum CE voltages of the 2N3738 and 2N3729 are 225 and 300 volts respectively, prices are $2.25 and $2.45 and they have a minimum f_T of 15 mc. Think of the fun you could have with these transistors for very compact, very high power, power converters: rectify the 115 vac, filter a little and use it to operate a high frequency oscillator that can use a very small toroidal core: the output will need very little filtering at those frequencies. More information on these transistors from your Motorola Dealer or TIC, Motorola, Box 955, Phoenix 85001.

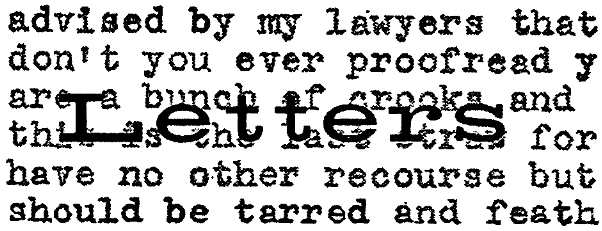
Sony Headset-Microphone Special



You know that you should use a handless mike for mobile, don't you? But you haven't gotten one because the price was too steep. Well, it isn't any more. Harvey Radio has a Sony combination headset and microphone for only $8.95. The mike is dynamic and the headphone is low impedance. The whole assembly is very sturdily built and comes with a carrying case. Send Elliot WA2HDP at Harvey Radio, 103 West 43rd Street, New York, N.Y. 10036 your $8.95 so you won't get killed mobiling.

Mark Antennas

Mark Products has a new catalog out that describes Mark's complete line of fixed and mobile antennas, mounts and accessories. You can get your copy of catalog AM-661 at Mark Distributors or from the factory at 5439 West Fargo Avenue, Skokie, Illinois 60076.



Letters

Headquarters
United States Military Assistance Command, Vietnam
APO San Francisco 96243

Dear Mr. Green:

After many years with no amateur radio activity in the Republic of Vietnam the recent activation of an amateur radio station here has caused a great deal of interest in the ranks of amateurs worldwide and especially among those amateurs now in, or about to come to Vietnam. ARRL bulletin #40, other published notices, and on-the-air discussions have caused this headquarters to receive an unprecedented number of requests for information concerning authorization to operate here. Answering these requests imposes an added burden that can be ill afforded. It is the purpose of this letter to explain the current status of amateur radio in the Republic of Vietnam and ask that you publish this information in 73 Magazine.

For many years the Republic of Vietnam has been torn by strife and it was in this setting shortly after independence was attained that amateur radio was banned and an exception to amateur operation was filed with the ITU. Until late in 1965 there was no legal amateur operation in this country. At that time the Government of Vietnam extended the privilege of amateur operating authorization to Deputy Ambassador William J. Porter, K1YPE, as a courtesy to a high ranking United States diplomatic representative. Simultaneously, action was initiated to withdraw the exception to amateur operation filed with the ITU to enable other countries to recognize his operation.

Ambassador Porter has been authorized by the Government of Vietnam to use the call XV5AA and there is no restriction on third party message and phone patch traffic. However, since other governments have not yet been notified of this action by the ITU, until they are Ambassador Porter is using the portable call K1YPE/XV5 for U.S. amateur contacts at the request of the FCC. His use of this call will cease when the ITU notification is received and he will then commence using the call XV5AA. He is already using XV5AA, however for contact with non-US amateur stations.

There have been some questions received concerning the prefix used for Ambassador Porter's call sign. The exclusive use of 3W8 for amateur stations seems to have been implied by certain published listings in which only 3W8 appeared, but this is incorrect and other listings correctly show both 3W8 and XV5.

While the Government of Vietnam has authorized Ambassador Porter to operate, this action does not represent a general change in the policy which strictly prohibits all other amateur radio operation. In addition, all personnel under military jurisdiction are subject to Military Assistance Command, Vietnam (MACV) Directive 105-6, 14 Dec 65, which prohibits amateur operation in Vietnam.

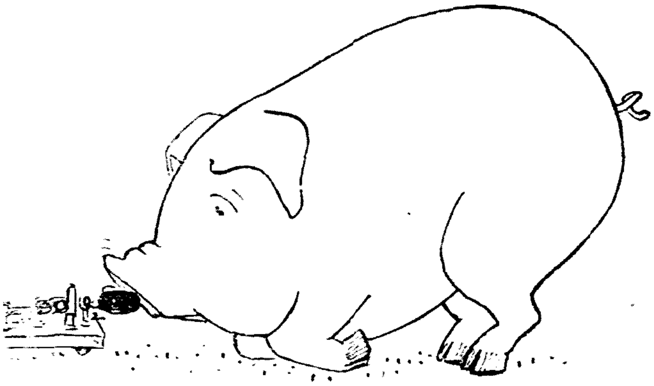
There have been many requests for amateur operation and all, with the exception of Ambassador Porter's have been turned down. Ambassador Porter will continue to encourage the Government of Vietnam to grant additional amateur operating authorizations when in its opinion conditions in the country make that practical. It should be remembered that it has not been the practice of most governments to permit amateur activity in time of war.

Ambassador Porter has found there is almost a complete lack of knowledge in this area on the subject of amateur radio. He has stated his desire to help amateur radio get a start in the Southeast Asia area and as the situation permits he hopes to carry on his educational program to bring about a better general understanding of amateur radio activity. This, however, will take time and for personnel in Vietnam now, or going there, Ambassador Porter has already accomplished something of immediate benefit: With his help a MARS system was authorized late in 1965, after three years of effort. There are Army, Navy, and Air Force military unit MARS stations in operation, but individual member and club stations are prohibited. The support for MARS operation rests in large part with licensed amateurs volunteering to operate the stations. As a result many amateurs can satisfy their desire to operate by offering their assistance to the local Army or Air Force MARS Director or Navy MARS Cognizant Officer.

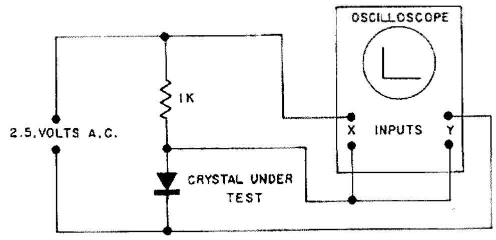
The MARS net structure consists of one in-country net in which all stations may participate to exchange message and phone patch traffic in-country and each station participates in an Army, Navy, or Air Force Pacific area MARS net.

The MARS operation is expected to expand, but amateur operation is expected to remain in the present status for some time. In view of this, individual amateurs are urged to refrain from writing for late information concerning amateur operation in Vietnam. If there is any change in the policies concerning amateur operation in the Republic of Vietnam, this headquarters will disseminate the information promptly.

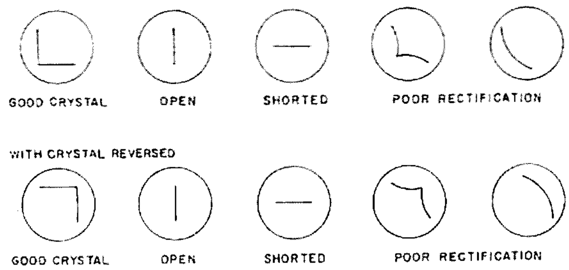
Sincerely yours,
Walter E. Lotz Jr.
Brigadier General, USA
Assistant Chief of Staff, J-6



Diode Checker



SCHEMATIC DIAGRAM OF CRYSTAL TESTER



This isn't a new idea, but it may be new to some of you. It's a simple method for checking all types of semiconductor diodes. The schematic shows the connections. What we are doing is checking the front-to-back ratio of the diode to give an indication of its merit. To calibrate the scope, connect a one kilohm resistor in place of the diode and adjust the scope's gain controls until you get a straight line at a 45 degree angle to horizontal. Then place a diode in the circuit and compare it to the diagram.

. . . K8ABR/4

Built-In Speaker for the TR-3

Like to have a speaker in your Drake TR-3 and avoid the inconvenience of having to connect an external speaker when you move the rig? You can mount a Quam #3AC5 speaker on the top cover near the front centered over the RF Tune control shaft between the Plate and Load shafts. The speaker is 3½ inches deep and has the same impedance and power capabilities as the TR-3. It sounds fine, too. You don't need to drill any holes since small bolts can be inserted through the holes in the top cover. Use a cable with a phone plug to attach the speaker voice coil up. The cable can be routed to the back and held in place with cable clamps.

. . . K5SGP

(continued from page 2)

And CQ's latest blast has set shock waves of indignation rippling with their attack on DXpeditions and proposal for the elimination of all further DXpeditions. I doubt that they would publish such opinions if there were any active amateurs on the staff. There aren't, are there? For that matter, are there any active amateurs on the staff at QST? The only one I've ever heard there was Dick Baldwin and he seems to have been fired from the magazine. Oh yes, Ed Tilton gets on the VHFs now and then.

Get a balloon?

This Oscar business is all OK, I guess, but they seem to be having an awful lot of trouble with it. Not only are the specs for a satellite very exacting, but we have to thumb a ride from Uncle Sammy . . . and Sam doesn't always go to our stop on the line.

The Air Force has been doing some research lately on UHF repeaters sent up by balloon and having considerable success over a 500 mile range. This sounds pretty good to me. If they can get 500 miles range on phone with the gear they're using we should be able to double it or better using CW.

If anyone or group is interested in building some ham repeaters for our VHF bands 73 will be happy to provide the balloons and gas to send them up. I would think that they should be sent up from the west coast on weekends. We might be able to get quite a bit of activity on 432 and 220 if we lofted a series of repeaters to crossband repeat to two meters from them. Are there any clubs that are interested in coordinating such an effort?

Your help requested

CQ has had some very strong things to say about the Institute of Amateur Radio. I would like very much to hear from any of you (or your friends) who have held back joining the Institute as a result of the editorials in CQ. If their editorials or word of their editorials have reached you and influenced you to refrain from joining the Institute then it is of great importance to let me know about this.

A careful and full accounting of every dollar spent by the Institute has been published in the Institute bulletins and all members are aware of exactly where the money is going and what it was spent for. There are none of those incredible ambiguities you find in the ARRL financial report.

Manufacturers help

DXpeditions do help bring interest to ham radio. Those of us at home get a big kick out of working them and getting a "new one." I'd like to see more manufacturers lend a hand to fellows who are putting on good clean DXpeditions. Hammarlund has been doing it almost single-handed of late and getting precious little credit for all their effort and expense. It seems to me that they have leaned too far backwards and as a result few fellows realize what a terrific help they have been.

History

While out in California I got together with a real old timer and got an interesting earfull of the early history of ham radio. His version is so different from that taught by the League that I don't know what to believe anymore. Perhaps some of you that were there then and had an inside track on what was really happening can clue me.

For instance, is it true that the main reason that Maxim started the ARRL was to promote his ego? I know that many of the directors seem to run for this reason today, but I hadn't realized that it might have been that way in the past. Maxim had a famous father and grandfather (Maxim silencer) and could have had that psychological problem.

And was it true that Maxim dug up Warner in a saw mill and that he got 25¢ personally out of each subscription to QST for several years?

I do know that the League keeps pointing out that if it wasn't for them we wouldn't have ham radio today and when anyone is discourteous enough to ask them to explain this they refer vaguely to the hams getting back on the air after world war I. Now I hear that it was the Army and Navy that put the pressure on at that time for us and that we have no debt to the League at all!

And did the League indeed have stock in one of our leading equipment manufacturers? This might explain why they specified their parts by number in virtually every construction article for some years.

Then there was the time we lost big parts of our ham hands at an ITU meeting with no observable battle put up by our leaders. Some of those that were there wanted to know why our leaders turned up with expensive cars and big new houses if it wasn't from some sort of payoff by commercial interests.

Judging from the number of scandals which seem to have been covered up there is an interesting story to be told. Perhaps one of

you old timers will write that story for us youngsters, changing names just a bit to protect the guilty. I do think that we should have some sort of history other than the sugar coated rewrite that appeared in QST.

. . . Wayne

Little League

One reader wrote, "Quite frankly I have been very skeptical of many of the things Green has been writing about the League in 73. His accusation that they had refused to let 73 exhibit at the National Convention in Boston seemed so ridiculous that I decided to check this for myself and see whether Green has been telling the truth or exaggerating about the state of affairs at League HQ. I was unable to get through to Huntoon, but I did reach an assistant and he confirmed that the League has indeed instructed the Boston Convention Committee not to permit 73 to exhibit at their convention."

This chap goes on to say that he is going to do everything in his power to keep his friends from attending the convention. Several other fellows have written similar letters and some manufacturers have indicated that they want no part of the show if that is the way it is going to be run. I disagree. A convention is primarily for the benefit of the hams that attend and I think we should all support the Boston Convention for the good of amateur radio in spite of the pettiness the League has demonstrated.

Pandora's Box explodes

The FCC ruefully admits that it never dreamed that they would get things in the mess they are now as a result of Part 15, the rule which permits those 100 mw transceivers which have been causing further chaos with already chaotic CB. FCC staffers admit that it is already way too late to try to stop the flood of these transceivers and they are talking seriously of moving them into some other band below 30 mc to relieve the CB congestion.

Those of us using six or ten meters have more than adequate reason for alarm. Virtually every other VHF user has a lobby in Washington to forcefully present the many reasons why this screaming mob should not be integrated with their service. They have millions of dollars to spend for their protection. Amateur radio has only the Institute of Amateur Radio, backed by a few hundred amateurs who care enough to try to keep ham radio going, to hold up its end of this battle.

Perhaps we need to lose one of these major bands in order to wake up the thousands of

amateurs who are mistakingly depending on the sleeping giant in Newington for protection. Fellows, the League isn't even a registered lobbyist for amateur radio . . . how can they possibly help you? They are good at proposing rule changes to force the old timers off the air, but they can't walk into a Congressman's office and ask for help.

On the other hand, perhaps those 100 mw gadgets are fun enough for us?

Chuck and Ted

Details will be following, of course, but the report now seems confirmed that Chuck Swain K7LMU and Ted Thorpe ZL2AWJ have been lost at sea during a hurricane after leaving Wallis Island on January 27th. I guess most of us expected some sort of miraculous escape such as Danny pulled off a few years ago down in those waters when he ran onto a reef with the Yasme.

Don Miller rushed out to Samoa to help with the search, but after over two weeks of scanning every possible area where they might be there has been no sign of them. Apparently they had left their ham gear behind on Wallis Island, which explains why none of us heard a QRRR.

(continued from page 4)

Second place went to Bill Richarz WA4VAF and Bryant Holmes WA4WOL. Their cover will appear in the near future.

We had an incredible number of entries in the contest and had a terrible time deciding the winners from among them all. There are a few others we may be able to use or that furnish good ideas for an artist to work on (some weren't finished artwork). Incidentally, we can always use good covers and cover ideas. Payment for covers is $25 and up. Ideas get less, of course.

Articles and other contributions

We always need good articles, too. We have a large backlog, but eat up 25 to 35 per month, so can't get too complacent. Among the articles we especially need are detailed ones on newcomers' gear. These should have layouts, lots of good large pictures, parts lists with prices and sources, and complete information so that an absolute beginner can use the article. We need receivers, transmitters and accessories for 80, 40, 15 and 2. Modern equipment is preferred; no 6SN7's and 6J5's. In fact, there's really no reason for not using semiconductors in the receivers and power supplies and possibly in the transmitters.

We'd also like articles on a 6 meter SSB KW linear (with maybe 572B's, 8236's or 8163's), 160 meter gear, a low noise (transistor) 1296 mc converter, test equipment, microwave equipment, simple transistorized SSB exciters, transmitters and transceivers using McCoy or CC crystal filters, circuits using cheap new transistors, and projects that use (or can use) printed circuit boards that can be made available to readers such as the keyer in the January issue. This list is by no means exhaustive. You can send a query on your project or just send the article itself (which I prefer). We like lots of good big pictures and try to use them. Polaroid shots usually are poor as they can't be blown up.

We also need *good* cartoons and cartoon ideas. For some reason, we seem to get a lot of non-ham and non-funny cartoons.

Comments

We're always anxious to receive comments from our readers about 73, and about particular articles in 73. Have you built a project from an article in 73? Why not send us a picture of it and your comments about any problems or modifications—or just how it worked. Your experiences can be very helpful and reassuring to others who want to build the equipment. . . . Paul

BROAD BAND BALUN **$10** net ppd. In U.S.A.
• Flat in the amateur bands from 3 to 30 Mcs. • Full legal power • Fully weather sealed • Matches coax to antenna or balanced line. • Improves efficiency and radiation pattern.

Two models, 1 to 1 or 4 to 1 impedance ratio
Size 1¼" OD x 4" long. Wt. 4 oz.

FUGLE LABS 1835 Watchung Ave., Plainfield, N.J.

ABSORPTION UHF WAVEMETERS

Hand calibrated from crystal oscillators by K1CLL. Now you can find the 432 and 1296 mc bands. Know the frequency of your doublers, triplers and oscillators. Don't guess!

VHF-1 40 to 135 mc
VHF-2 140 to 355 mc
UHF-1 350 to 675 mc
UHF-2 600 to 1100 mc
UHF-3 950 to 1400 mc

$9.75 each
All five for $45

Hoisington Research Company
Far Over Farm, 603-924-3030, Peterborough, N. H.

PRICE BREAKTHROUGH ON BEAMS

FULL SIZE; new; complete with boom and hardware; SWR, 1:1; handles 5 kw; adjustable entire band; ⅞" and 1" aluminum alloy tubing; coax feed:

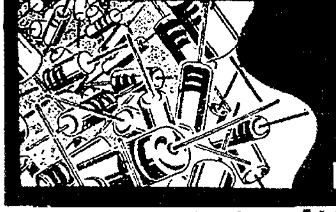
3 el 20	$22	3 el 15	$16
2 el 20	16	2 el 15	12
4 el 10	18	4 el 6	15

VERTICALS: ALL BAND V160 (6 thru 160) $18.95

QUADS: NEW! NEW! ALL METAL (except insulators) Cubical Quads; 2 el; full size; complete with boom, all hardware; terrific gain and directivity; best quad ever made; no bamboo: 20 meter $25; 15 m $24. Remit with order, shipped express collect.

GOTHAM, 1805 Purdy Ave., Dept. 73, Miami Beach, Fla. 33139

1000 COMPOSITION RESISTORS



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→ SURPLUS WANTED ←

We'll pay you the absolutely Highest Prices for almost any piece of equipment in any condition. We'll trade also. We'll pay in 24 hours too. Just send list, or telephone collect for quick quote. Particuarly interested in all AN/GRC, PRC, ARC, ARM, UPM, USM, APR, APN, URM, RT-66-70, T-195, R-392, etc.
SPACE ELECTRONICS, 4178 Park Ave., Bronx, N.Y. 10457
(212) CY 9-0300

→ SURPLUS WANTED ←

Caveat Emptor?

★ **Price—$2 per 25 words for non-commercial ads; $5 per 25 words for business ventures. No display ads or agency discount. Include your check with order.**

★ **Type copy. Phrase and punctuate exactly as you wish it to appear. No all-capital ads.**

★ **We will be the judge of suitability of ads. Our responsibility for errors extends only to printing a correct ad in a later issue.**

★ **For $1 extra we can maintain a reply box for you.**

★ **We cannot check into each advertiser, so Caveat Emptor . . .**

CLOSED CIRCUIT television camera, video monitor, assorted TV lenses. Very reasonable. Ira Klein, 1439 52 St. Brooklyn. Phone HY 4-7083.

ART'S QSL'S Samples 10¢. Art Bliss, 1829 N. Catalina St., Burbank, California.

CONVERTERS $10 and up. World's largest selection of frequencies. Ham TV vidicon cameras and parts at low factory-direct prices. See them all now in our full page ad in this issue. Vanguard Labs, 196-23 Jamaica Ave., Hollis, N.Y. 11423.

WE WILL PAY CASH: **Wanted, popular, late model unmodified amateur equipment. Highest prices paid for clean, good operating gear. Write Graham Radio, Dept. 10, Reading, Massachusetts.**

TECHNICAL MANUALS. Signal Corp. Some of the available manuals R-390,A, SP-600, BC-610, I-177, TV-7, teletype manuals, test equipment. World's largest list 10¢. Quaker Electronics, Hunlock Creek, Pa.

ARE YOU SINCERE? Are you *really* looking for the best deal on a new or fully guaranteed used unit? Let us convince you with a specific quote that will *really* save you money. Graham Radio, Dept. 10, Reading, Massachusetts.

CLERGYMEN OF ALL FAITHS! Sixth edition of "Clergy and Religious Radio Operators" callbook to be published soon. Please inform us of additions and changes. Over 1000 calls now included. No cost or obligation. Write: Callbook, Capuchin Seminarians, K1QFT, Box 218, Hudson, New Hampshire, 03051.

NC-300, 2 and 6 Converters, speaker, $150.00. 15 Ampere Variac $20.00. Heath AG-9, $20.00 SASE for list, W2EET, 2 Ridgeway, Ave. Oaklyn, N.J. 08107.

NIXIE TUBES, Burroughs no. 6844A. Have 50 @ $5.50 ea. postage paid. New, No pullouts. W4FSB, Duke Russell, 1815 Missile View Ave., Merritt Island, Fla. 32952.

CANADIANS, TRANSISTORS all semiconductors and components. Free catalogue contains reference data on 300 transistors. J. & J. Electronics, P.O. Box 1437, Dept. 73, Winnipeg, Manitoba, Canada.

QSL CARDS: **Samples 10¢. Quality—reasonable—fast service. Decals, rubber stamps, photo labels, log books or loose leaf. Malgo Press, Box 375, Toledo, Ohio 43601.**

FT-243 CRYSTALS: 0.1% setting $2.00 each, ±2 kc setting $1.00 each. 3000-8700 ks. Denver Crystals, 776 South Corona, Denver, Colorado 80209.

WANTED GOLDKIT THRILLER transceiver in good shape. Box 731, Jacksonville, Florida.

WANTED GOLDKIT THRILLER transceiver cheap. Box 84, Brunswick, Georgia.

WANTED British DX transmitter EL 37 in good condx. Box 45, Jax, Fla.

CLEGG 22′ $175, Drake R4 with speaker $300, #19 teletype machine includes table, power supply, TD unit, $150—you pick up. WA8BLS/4, 6420 5th Avenue, N., St. Petersburg, Florida 33710.

KNIGHT GRID DIPPER $15, Transtenna 102A T-R $30, Vibroplex vibrokeyer $8, 73 Bound volume #1 $8. Tony Casciato, 1107 Cottage St. SW, Vienna, Va. 22180.

COLLINS 62S-1 $575, KWM-2 with Waters Q-Multiplier $675, 516F2 $50, Package $1250. All factory new condition. Measurements Corp. Model 59 GDO $95. J. W. Gregory K4OCK, 6495 Killian X Drive, Miami, Fla. 33156, MO 1-7576.

GR 650A RLC Bridge $85, ART-26 $50, ARC-1 $15, Allstate CB rigs new $30 each, LM with calibration book and PS $50, New 4-400 $25. R. Wurtzinger, 830 N. Waller, Chicago, Ill.

KNIGHT R-100A receiver with crystal calibrator $85. Eico 723 transmitter $35. Plus shipping. J. Buck, 4860 West Richfeild Rd., West Ridgefield, Ohio 44286.

CUBICAL QUAD W2AU for 10-15-20 meters, never used, complete instructions $40. Pick up deal only. Sorry. James J. Doran, 178-09 132nd Avenue, Springfield Gardens, L.I., N.Y.

WANTED: Linear with power supply to follow 20A. Good quality homebrew OK. Or will swap 20-A deluxe VFO, 2-B with calibrator plus cash for Swan 350 or 400 plus VFO and AC supply. Paul Wentzel KØGBC, RFD #2, Box 451, Spearfish, So. Dak. 57783.

HA-1 KEYER and Vibroplex. Almost new. Swap for Tri Band Beam or $70. WA1BWS, Roger Burnham, RFD #1, Danby, Vt.

HAM AUCTION May 2, 1966. Check gear in at 6 pm. Auction at 8 pm. River Park Amateur Radio Club, 5100 North Francisco Avenue, Chicago, Illinois.

600 PIV TOPHATS, includes bypass capacitors and resistors 10 for $3. Postpaid USA. Tube pullouts: 4CX250B $6.50, 4-125A $5.00, 6146 or 6883 $1.25, 5763 or 6CL6 $1.00, 4X150 $4.00, 2C39 $2.00, 304TL $15.00, 4-250 $10.00. All material guaranteed. Minimum order $3.00. East Coast Electronics, 123 St. Boniface Rd., Buffalo, N.Y. 14225.

RTTY CHANNEL FILTERS tuned to specific frequency .0005. $3 each. Two tuned filters mounted in an octal can $9. 5 88 mh toroids $2. Postpaid. Bob Jeffrey W6OKK, 6639 Outlook Avenue, Oakland, California.

AN/URR-13A receiver $88; General Radio 1551-A $139.50; Teletype MD 14 reperforator $47.50; Infrared Sniperscope Md M3 $125; NiCad battery-cells. P. E. Boniface, P.O. Box 44, Hawthorne, Mass. 09137.

SWAP COAST GUARD BC 653-A transmitter with a 500 v and 1200 v generator complete, 140 lbs of choice parts, pair 814's final G. mod. Need good communications receiver. Write E. R. Albertson, P.O. Box 392, Evadale, Texas 77615.

BC-348 Double conversion miniature tubes, with power supply, new panel. Diagram included, $45. Two new 4CX250K tubes with home brew socket, $10. J. E. Richardson, Box 54, Pottstown, Pa. 19464.

EICO 723 60wt CW Xmtr w/spare tubes. Good novice rig. Wkd 20 countries. $40. J. F. Robinson, K1ZJW, 32 Old Colony Way, Scituate, Mass. 02066.

ELECTRONIC LIGHTER. No Flint, Wick, Battery or Moving Parts. PHOTO OF SHACK with call, name, address, on labels. Wagner Co., 6200-C Whitewood, Library, Pa. 15129.

HEATH HW-32 20-meter USB transceiver. 200 watts input, ALC, AVC, VOX, and PTT. Like new, $85. 16810 Weddington, Encino, Calif. 91316 213-784-2588.

WANTED: Military or Commercial Surplus . . . Airborne, Ground, and Testsets. Try the big boys, then write or call collect area 703-560-5480 and give us YOUR price . . . We Pay Cash and Freight . . . RITCO POB 156, Annandale, Va.

FOR SALE: R23/ARC5 190-550KC receiver good operating with tubes . . . $15.50; also R445/ARN30 Tunable late type command receiver 108-132MC, same setup as command sets . . . good operating with schem. . . . $26.50. RITCO POB 156, Annandale, Va.

BARGAINS! Transmitters, Receivers, Test equipment offered, wanted in ham's trading paper. Next 12 interesting issues $1. Sample copy free. "Equipment Exchange-Ham Trader," Sycamore, Illinois.

HALLICRAFTERS SX-117 with HA-10 plus xtal for 4-4.5 mcs, mint condition, only $270, will ship. Contact WA4MZZ, Box 182, Louisville, Georgia 30434.

QSL CARDS? Largest variety samples 25¢. Sakkers, W8DED, Holland, Michigan.

CHRISTIAN Ham Fellowship being organized for Christian Hams for fellowship, tract ministry, missionary efforts among hams. Christian Ham Callbook $1 donation. Write Christian Ham Fellowship, c/o W8DED, Box 218, Holland, Mich.

WRL BLUE BOOK prices save money. Take 10% off these prices without trades. Communicator IV's, 2M or 6M—$199.00; HT37—$269.00; SX99—$99.00; SX101A—$209.00; SR150—$389.00; Galaxy 300—$189.00; Galaxy III—$219.00; SB33 $209.00; NCX3—$219.00; RX1—$149.00; TX1—$139.00. Hundreds more. Free list. LEO, WØGFQ, Box 919, Council Bluffs, Iowa.

COLLINS STATION 75A1 Receiver with RME DB23 preselector $175. 32V3 Transmitter with spare 4D32's $200. Or make offers. WA4WHI, 10235 S.W. 58 Ct., Miami, Fla. 315-667-9906.

TUBES: 4CX1000A's, Brand New, $100.00. Insurance and shipping paid. WA5MCL, 130 Grecian, San Antonio, Texas 78223.

DAYTON HAMVENTION April 16, 1966—Dayton Amateur Radio Association's 15th annual Hamvention, Wampler's Ballarena, Dayton, Ohio. Participate in the technical sessions, forums, banquet, "Home Brew" contest and hidden transmitter hunt. Bring XYL. FCC general class examination 09:00 Saturday. For information write Dayton Hamvention, Department C, Box 44, Dayton, Ohio 45401.

NOVICE CRYSTALS 80-40M $1.05 each. Also other freqs. Free list. Nat Stinnette, W4AYV, Umatilla, Fla. 32784.

BC 348—Double conversion—miniature tubes with power supply, new panel. Diagram included—$15.00. Two new 4CX250K tubes with home brew socket—$10.00. J. E. Richardson, Box 54, Pottstown, Pa. 19464.

COMPLETE STATION—HX-50A-160 latest modifications, with 8236 final for 270 P.E.P.—$375.00; Drake 2A with Calibrator, speaker and extra xtals.—$160.00; Seneca VHF-1 6N2 with handbook 6146 modulator and power supply—$165.00; Viking 6N2 Converter—$40.00; BC-342N with stability, S-meter and speaker—$65.00. Jim Bellows, K8NIE, 2700 Parsons, Midland, Michigan 48640.

VIDICONS . . . RCA & GEC, Heath test equipment, Wineguard UHF converter, Surf Board, CDR rotor, HO-13 Hamscan, 2 meter halo, RG-17u, Radar Sentry, plus more . . . WB2GKF, Stan Nazimek, 506 Mt. Prospect Ave., Clifton, New Jersey 07012.

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2 METER FM mobile unit wanted, Motorola preferred. Give details, including chassis numbers, price. Jim Hill, W6IVW, 26107 Basswood, Palos Verdes Peninsula, Calif. 213-3784411.

COMPLETE STATION! Eico 720 Transmitter, 722 VFO, Hallicrafters S-108 Receiver, Heath Calibrator, Novice Crystals. 6 months new, good condition (61 countries, 44 states). Best offer over $200. WB2SSB, Joseph Sanger, 22 Teakwood Lane, Roslyn, L.I., N.Y.

CALL SIGNS! Now, You can proudly display your call, custom made in thick sand cast aluminum. Polished border and letters on a deep black background. Exclusive quality admired by all. Satisfaction guaranteed. Only $7.95 postpaid. Or send $1.00 deposit, balance C.O.D., to Robert Young, 2021 25th Street West, Birmingham, Alabama 35218.

NOW! A publication devoted entirely to government surplus electronic equipment. Many schematics and other data each issue. Sample copy 25¢ or $3.00 per 1-year subscription. National Surplus Digest, P.O. Box 36, Sweet Valley, Pa.

I DON'T ENJOY WORKING SSB. Have near new Heath HW-12 with HP-13, DC supply and xtal calibrator. Highest bidder. James Bean, KØLRO, Belcourt, N. Dak. 58316.

GOODY BAGS, 20 pounds excellent parts $5. Catalog —RTTY, UHF, Receivers, parts—send SASE. 0-322/GPA-30 unused, $9.50 fob. BVE Enterprises, POB 411V, Paramus, N.J. 07652.

HALLICRAFTERS FPM-200 transistorized transmitter-receiver-transceiver. Completely self-contained, compact station incorporating advance features not found in any amateur radio at any price. 41 transistors, two VFOs for transmitting and receiving on different frequencies. AM, SSB, CW-VOX. Complete coverage from 10 through 80-meters, plus WWV. 16" wide, 5" high, 11" deep. Complete with AC unit and self-contained mobile bracket. Can be moved in seconds. This magnificent piece of equipment sold for $2650. Absolutely perfect condition. Will sell for less than half-price. WA6TLS, 7549 East Fourth Place, Downey, California.

NEW TOOOOOBES: 6146B—$4.00; 6CW4—$1.40; 417A—$3.95; 6360—$3.45; 6146—$2.55; 3-400Z—$30.80. NEW, boxed, guaranteed. NO pulls, seconds or JAN. Free Catalog. VANBAR dist. Box 444X, Stirling, N.J. 07980.


Little Annie Hammy
BY WAYNE PIERCE-K3SUK
THIS MONTH WE FIND OUR PRECIOUS HEROINE'S LONGTIME PAL, PERCY, ON THE VERGE OF STEPPING INTO THE WONDERFUL WORLD OF HAM RADIO... WE OPEN OUR STORY WITH PERCY ON ANNIE'S PRECIOUS LITTLE DOORSTEP..
DING DI DING DIT
DING DING DI DING
HOW TO
GOLLY GEE 73! IT'S TIME FOR OUR LITTLE CODE PRACTICE AND THEORY SESSION
COME IN, PERCY
HI, ANNIE... JUST ONE MORE SESSION OF THE CODE AND I THINK I'LL BE READY FOR THAT NOVICE TICKET ... AND I'VE READ UP ON ALL THOSE LITTLE RESISTOR AND CAPACITOR THINGS...
OH, PERCY! I'VE ALWAYS THOUGHT OF YOU AS BEING REAL HAM MATERIAL!
LATER
THAT WAS WONDERFUL, PERCY! A WHOLE COLUMN OF 'W2NSD/I' AT 5-WPM WITHOUT A SINGLE MISTAKE... AND YOU DIDN'T GET HYSTERICAL ONCE!
WEEKS LATER...
ANNIEBAAAABY!
I'M A HAM!
I'D SAY HE'S MORE OF A PORKCHOP


JUST THINK, ANNIE! 'CQ TIBET... CQ TASMANIA... CQ PETERBOROUGH... WATSA, OLD MEN?... HOW COPY, GUS? SORE, I QSL... QRU?... QRS?... ROGERDODGER... QRZQRZQRZ QRZQRZQRZ? .....'
OH, PERCY...YOU'RE A REAL HAM! WHY DON'T YOU COME ALONG TO THE HAM CLUB WITH ME TONIGHT AND MEET THE LOCAL FELLOWS?
OH BOY!
WHOOPIE!
HOT DOG!
GEE WHIZ!
CLOUD/9
THAT EVENING...
PUNKDUCK HOLLOW RADIO
NO CBERS
GDO
FELLOWS... MEET PERCY!..... HE'S THE TOWN'S NEWEST HAM ...HE JUST GOT HIS TICKET TODAY!
THE AMATEUR IS
HI PRCY BT GLD TO MEET U BT NME HR IS CLYDE ES I'M A CW MAN MYSLF SK
CW FOR-EVER!
AWWWH...HOPE TO HEAR YOU ON GOOD OLD 75 'PHONE WHEN YOU GET THAT BIG TICKET... AWWWH... THAT'S WHERE YOU'LL HEAR ME! HAR HAR HAR...
WHATDIDHESAY?
YOU HAVE TO SORT OF WHISTLE WHILE HE TALKS... HE'S A SIDEBANDER...


MEET OSCAR... HE'S A VHF OPERATOR...
THIS IS CHARLIE... HE'S A DEDICATED RTTY HAM... WRITE HIM A NOTE — HE'S NOT MUCH FOR TALK
AWWRIGHT, YOU LIDS... LET'S GET THIS MEETING STARTED!
AWWRIGHT... LET'S GO WITH THE ROLLCALL ... DON'T NOBODY BREAK IN OUTA TURN OR IT'S THE WOUFF HONG...
YOU CAN MEET SOME MORE OF THE FELLOWS AFTER THE MEETING... ISN'T THIS A WONDERFUL GROUP? ALL REAL HAMS — EACH WITH HIS OWN TALENTS CONTRIBUTING TO THE WHOLE OF THAT GREAT SERVICE — AMATEUR RADIO... PERCY? PERCY!
I WANTA GO HOME...
I DON'T WANTA BE A REAL HAM! I DON'T WANTA GET INVOLVED.. I JUST WANTA WORK AUSTRALIA ONCE OR TWICE A WEEK AND BUILD A TRANSMITTER OR TWO AND JUST FOOL AROUND WHEN I FEEL IN THE MOOD AND... AND.. .....
I'LL NEVER GET THAT WRAPPED UP IN HAM RADIO... THOSE GUYS HAVE GONE THE LIMIT!
WANT TO STOP IN FOR A CUP OF HOT CHOCOLATE?
THANKS, BUT I WANT TO GET HOME AND GET STARTED ON SOME AWARDS... I MADE FOUR DOZEN CERTIFICATE FRAMES THIS WEEK...
QRT

Propagation Chart

April 1966

J. H. Nelson

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	7#	7	7	7	7	7	7#	14	14	14*	14
ARGENTINA	14	7*	7*	7	7	7	14	21	21	21	21*	14
AUSTRALIA	14	7#	7#	7*	7	7	7*	14	14#	14	14	14*
CANAL ZONE	7	7	7	7	7	7	14	21	21	21	14	14
ENGLAND	7	7	7	7	7	7	14	21	21	14	7#	7
HAWAII	14	7	7	7	7	7	7	7#	14	21	21	14
INDIA	7	7	7#	7#	7#	7#	14	14	7#	7#	7#	7
JAPAN	7#	7#	7#	7	7	7	7	7	7#	7#	7#	14
MEXICO	7*	7	7	7	7	7	7	14	14	14*	14#	14
PHILIPPINES	7*	7#	7#	7#	7#	7	7	7	7#	7#	7#	7*
PUERTO RICO	7	7	7	7	7	7	14	14	14	14	14	14
SOUTH AFRICA	7#	7	7	7#	7*	7*	14	21*	21	21	14	14
U. S. S. R.	7	7	7	7	7	7#	7*	14	7#	7#	7#	7
WEST COAST	14	7	7	7	7	7	7	14	14	21	21	14

CENTRAL UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	7#	7	7	7	7	7	7	7#	14	21	14
ARGENTINA	14	7*	7#	7	7	7	14	21	21	21	21*	14
AUSTRALIA	14	14	7*	7*	7	7	7*	14#	14	14	14	21
CANAL ZONE	14	7	7	7	7	7	7*	14	21	21	21	14
ENGLAND	7	7	7	7	7	7	7#	14	14*	14	7#	7
HAWAII	14	7*	7	7	7	7	7	7#	14	21	21	21
INDIA	7	7	7#	7#	7#	7#	7#	14	7#	7#	7#	7
JAPAN	14	7#	7#	7	7	7	7	7	7#	7#	7#	14
MEXICO	7	7	7	7	7	7	7	14	14	14	14	14
PHILIPPINES	14	7#	7#	7*	7*	7	7	7	7	7#	7#	14
PUERTO RICO	7	7	7	7	7	7	14	14	21	21	14	14
SOUTH AFRICA	7*	7	7	7#	7*	7#	14	21	21	21	14	14
U. S. S. R.	7	7	7	7	7	7#	7*	14	7#	7#	7#	7

WESTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	7	7	7	7	7	7	7	14	14	14*
ARGENTINA	14	14	7*	7	7	7	7*	14	21	21	21*	21
AUSTRALIA	21	14	14	7*	7	7	7	7*	14	14	14	21
CANAL ZONE	14	7	7	7	7	7	7	14	21	21	21	21
ENGLAND	7*	7	7	7	7	7	7	7*	14	14	7#	7#
HAWAII	21*	14	7	7	7	7	7	7	14	21	21	21*
INDIA	7*	14	7#	7#	7#	7#	7	7	7	7#	7#	7*
JAPAN	14*	14	7#	7	7	7	7	7	7	7#	7#	14
MEXICO	14	7	7	7	7	7	7	7	14	14	14	14
PHILIPPINES	14*	14	7#	7*	7#	7	7	7	7	7*	7#	14
PUERTO RICO	14	7	7	7	7	7	7#	14	21	21	21	14
SOUTH AFRICA	14#	7#	7	7*	7#	7#	7#	14	14	21	21	14
U. S. S. R.	7#	7	7	7	7	7*	7*	7*	7#	7#	7#	7*
EAST COAST	14	7	7	7	7	7	7	14	14	21	21	14

Very difficult circuit this hour.
* Next higher frequency may be useful this hour.

Good: 1-3, 7-9, 13-15, 24-26
Fair: 4, 6, 10, 12, 16-19, 21-23, 27-28, 30
Poor: 5, 11, 20, 29
VHF DX: 1, 5, 21, 25-28

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73 Magazine

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de W2NSD/1

never say die

Last call for Kenya

At this writing there are three of us going on an African Safari this August for three weeks. The total cost of the trip, including plane fare, guns, licenses, white hunters, the works, will run under $2000. There's room for one or two more. Let me know immediately if you want to go.

Keeping up

The QST Board of Directors meeting this May should be fascinating. On top of all their other insurmountable problems they have to replace Herb Hoover as president. Many of us hope that the Directors will take some action this year toward helping ham radio survive by insisting that the IARU be given some funds for communications and promotion. A little help in our own country would not be wasted either . . . perhaps if the League could put on someone in Washington, even if he is a very part-time man, to speak up for amateur radio? And how about the information vacuum caused by the League refusing to do promotion work for ham radio? The Oscar series, though of international importance, were well-kept secrets . . . as is just about every other benefit provided by amateur radio.

Of course the Directors should take some action to stop the drop in membership. It has been dropping every year now for four years, you know. Perhaps if we could all have more confidence in their choice of employees, more amateurs would join the League. None of us like to support a dictatorship.

And if the QST Handbook continues to be the slip-shod book it has for the last few years, I give you warning that 73 will put one out that is done right. Fair warning? The Directors should do something about that inexcusable mess!

Perhaps, instead of interminable motions for congratulations, as seem to fill most of the few hours of the once yearly Board meetings, there should be some time devoted to Motions for Censure. Harry Dannals should get some mention for his part in the K2US disgrace. And Huntoon should get a commendation for his attempts to strike back at 73 by forcing the National Convention Committee to exclude 73 from the convention. This monument to small thinking should not go unrewarded.

While the commendations are being handed out, perhaps one should go to the Oscar group for continuing to exist in spite of the usurping of the limelight at every opportunity by Bill Orr.

Mysteries

Scientific anomalies interest me. Sure, I know that most of them turn out to be fakes, but that doesn't spoil the fun at all. I try to get together with John Campbell W2ZGU, the editor of Analog magazine, whenever I can, because he is just full of these interesting stories.

I remember John telling me about a chap out in Colorado who had a power pack of some sort . . . black box type . . . and he would take it out for a demonstration anywhere you wanted him to, far away from commercial lines. He would then hook a tremendous load onto his power unit—it was about the size of a small suitcase—and turn out hundreds of kilowatts of power. You knew it wasn't batteries because it wasn't that big or heavy . . . what was it? I understand the chap was willing to sell the bag for around a million dollars.

In the March issue of Popular Electronics there is a story about a chap in Sarasota that can send signals through water with a little

(Continued on page 112)

Editor's Ramblings

Lids

The article "How to Be a First Class Lid on Phone without Really Trying" in the February issue apparently stepped on many toes. We apologize to all the lids we offended.

Questions

People (mostly hams) write us all the time with questions. Most are fairly straightforward, and if we had a staff of five EE's with nothing else to do, we'd be happy to answer them. Unfortunately, we don't have those EE's. We don't have *anyone* here with the time to answer questions, whether they are reasonable or not. Please consult our indices each January or standard handbooks. You may not find your answer, but you'll certainly find something of interest. Please don't send us questions. And if you simply must, include a self addressed envelope so we can send back our form that states that we can't answer your question.

Incidentally, please enclose a self addressed stamped envelope when you write to 73 authors. Many get an awful lot of mail about articles and are perfectly justified in throwing away all questions unless you do this.

Hz

For many years the English speaking world has used cycles per second (cycles, we usually say for simplicity) as the unit of frequency. Continental Europe has used hertz, obviously from the same source as amperes, volts, gilberts (gilberts?), etc. Hertz is simpler and shorter, but cycles per second has the advantage of reminding us of its meaning, though this advantage is obviously unimportant after you've spent a few days reading radio books and know what cps means. The big advantage of cycles is that we're used to it, so seeing 455 kHz instead of 455 kc tends to jar us.

(Continued on page 115)

Take it from us...

and who the hell hasn't?

We began the manufacturing of ham gear not too many years ago on the simple premise that there was considerable room for improvement, particularly in the accessory field. It was our contention then as now, that up-dated equipment engineered right, built right and priced right would find a waiting market with the amateur. It did and it does!

From the very start we set our sights high, picking up where others had bogged down in the dogma of "it can't be done." Truthfully, improving on the products of some of the let-well-enough-alone makers was no considerable feat. They were sitting ducks for our kind of thinking. By ignoring trends and advanced theories they had continued year after year with the same antiquated items . . . never venturing, never daring, never doing.

Waters developed the Auto-Match mobile antenna because there was need for it. Need for an antenna that was structurally strong enough to withstand the rigors of mobile use. Need for an antenna electrically capable of pushing out a stronger signal. An antenna capable of handling the thousand watts PEP of the new mobile rigs being introduced. We had something too good to go uncopied for long. Within six months, manufacturers who hadn't incorporated a change in their antennas since initial introductions, latched on to Waters improvements, heralding their "innovations" to the high heavens and lauding long-dormant engineering skill.

The erstwhile leading co-axial switch maker had been turning out the same outmoded product since proverbial Hector was a very young pup. Originally improvised around a standard wafer selector switch (misalignment and all) it was never changed, never improved. Never, that is, until Waters engineered a totally new approach in co-axial switches. It took the old timer about four months to get into the me-too act with a completely new line based on you know what! Recently we announced "Protax", the only automatic grounding co-axial antenna switch. Right now we're alone in the field, but we won't be lonely for long. Want to bet?

We perfected a couple of nifty speech-processing devices at Waters — the Compreamp and Clipreamp. We're proud of the compact circuitry and theory because it took considerable doing. Apparently one of the better kit manufacturers went along with our good opinions. You can now buy his version of Clipreamp in kit form. And, we're nasty enough to add, at a higher price than for our assembled job.

Most good CW ops are familiar with our now-famous Codax Automatic Keyer and its rhythm-smooth action. It seems another kit maker is familiar with it too, and offers a reasonable facsimile of same in kit form. You might do better by knocking down a Codax and ordering duplicate parts but we must warn you, assembly and adjustment can be very tricky.

There's more — but you get the idea! Some bright guy once ventured the thought that imitation was the sincerest form of flattery. If so, we've been flattered to a fare-thee-well and getting the least bit fed up. You can even get odds in our Engineering Department whenever we introduce a new piece of gear as to how long it will take the Brand X, Y and Z boys to incorporate Waters advanced thinking into their own products.

It all adds up to a pretty logical conclusion. Waters pace-setting ham equipment is engineered for tomorrow . . . and you can own it today. Or you can wait until tomorrow and take it from the guy who is taking it from us today.

Bob Waters **W1PRI**

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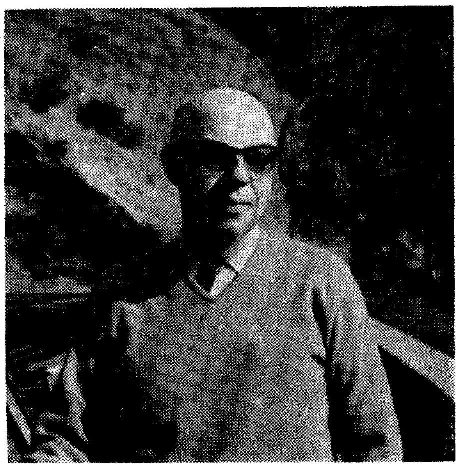
Sonoma, California 95476

New VHF Circuits for Transistors

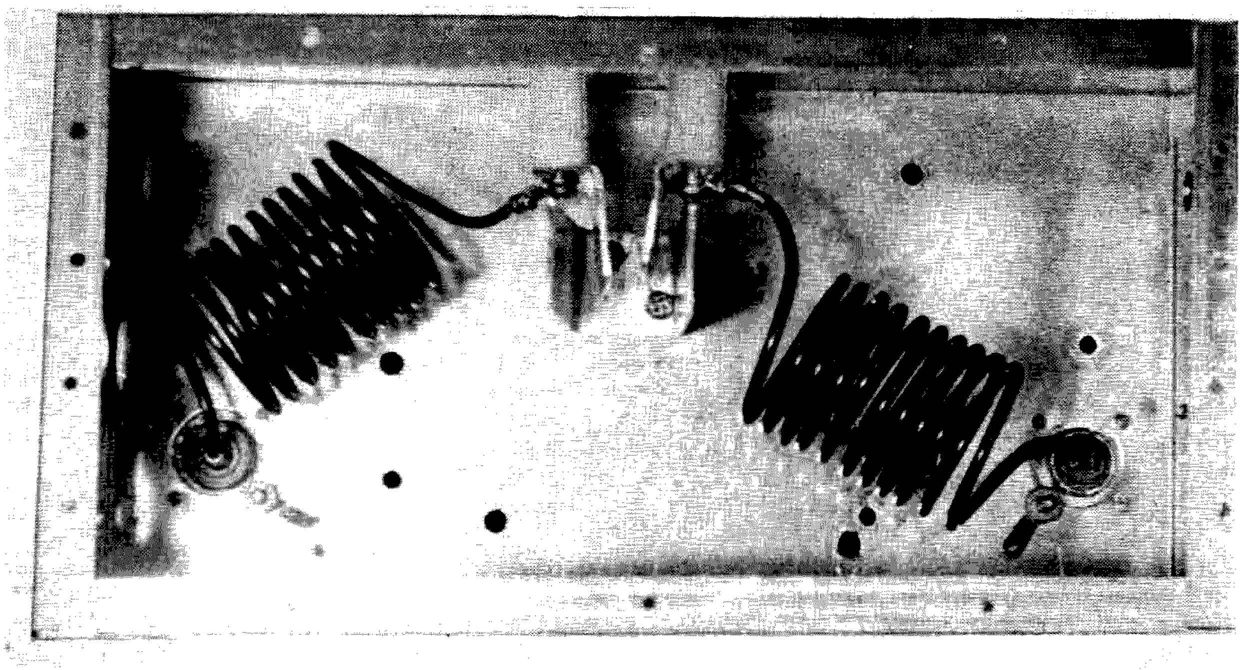
This article, the first in a series, describes a simple but effective 50 mc antenna tuner and low noise 50 mc converter using three 52¢ transistors.

Some sad experiences with transistor converters and receivers at my station have resulted in the use of several ideas for protection of transistors which now seem to be satisfactory for most overload conditions. These overloads in the past abruptly ended the useful life of the front end transistor or caused a gradual deterioration of receiver noise figure and loss of weak signals. Four general forms of overload were present at W6AJF. First, a high powered VHF transmitter connected to a beam antenna which was too close to another VHF band antenna and perhaps pointing across the other antenna at times. This would produce a damaging voltage across the input of the first transistor thru the antenna feeder, coax relay and input circuit (low Q) into the transistor even though that unit was not in operation, that is, with no battery connection. For a long time the only protection was to disconnect all antenna coax fittings except for the band in use. A good VHF contest with all antennas connected usually resulted in a frantic search for a new transistor or two.



The dual antenna couplers shown in this article cured this problem since two very high Q circuits added enough selectivity to the transistor converter front ends to knock out this problem. To get very high Q circuits these units have to be large physically, so a second benefit results from their use. Transmitter spurious frequencies are greatly attenuated and the rf energy reaching the particular antenna is confined to that particular band with a reduction of TVI problems in the neighborhood. These dual circuits were built into standard aluminum chassis and fastened on the wall for connection between the coax line of each beam antenna and its coaxial antenna relay. Very high Q is needed to not only reduce transmitting power loss but to

Frank Jones is one of the best-known and most capable of VHF hams and authors. He has written over 400 articles and radio handbooks, including "VHF for the Radio Amateur," a staple on any VHF'er's book shelf. This is Frank's first article in 73; we hope that it will be followed by many more.



Dual circuit antenna filter for 50 mc used in both transmitters and receiving.

keep from losing NF in the receiver. Any loss here reduces the weak signal capabilities so the losses should be kept well below one DB in the two circuits of each coupler.

If each circuit is coupled so as to have a working Q of perhaps 20 and the unloaded Q is perhaps 500, the total coupler circuit loss would be 8% or an efficiency of 92%. The loss in NF would then be less than ½ db. Small circuits cannot be built with high enough Q for low losses, and as much as 2 db is sometimes lost in NF if these selective circuits are built into the converter unit.

The second cause of transistor failures is fairly rare at this location, lightning storms in the area. These only occur once or twice a year here and the best protection is still to have all antennas disconnected from all receivers during these storms. Lightning protectors in the antenna feeders to a good outside ground may save the transmitters except in a direct hit, but transistors aren't tough enough and out they go even though the bolt of lightning may hit a few miles away. Low capacity fast diodes connected back to back across the first transistor circuit help a little.

The third cause of transistor failure has to do with improper antenna and power control relays. No matter how good an antenna relay is for isolation between transmit and receive positions, an arc at the points will sure put a lot of rf voltage across that first transistor. The answer to this problem is to manually control the relay switching or to use timed delay sequence by electrical means so the antenna relay will be in transmit position before the power relays are in transmit position—and most important, the power relays are "off" long enough for all transmitter rf energy to dissipate in the antenna before the antenna relay is restored to receive position. Some circuits which accomplish this properly have been or will soon be published. Antenna relay switching still seems to be the most effective way of getting those weak signals into the receiver in the VHF region.

A fourth cause of trouble is in the antenna relays because of lack of isolation between the transmit and receive coax connections. Nearly all VHF transistors will break down if the peak input voltage is much over a half volt. Some antenna relays only have about 20 db isolation at 144 mc, or a power isolation of 100 to 1. If you have 100 watts peak transmitter power output, this means 1 watt down

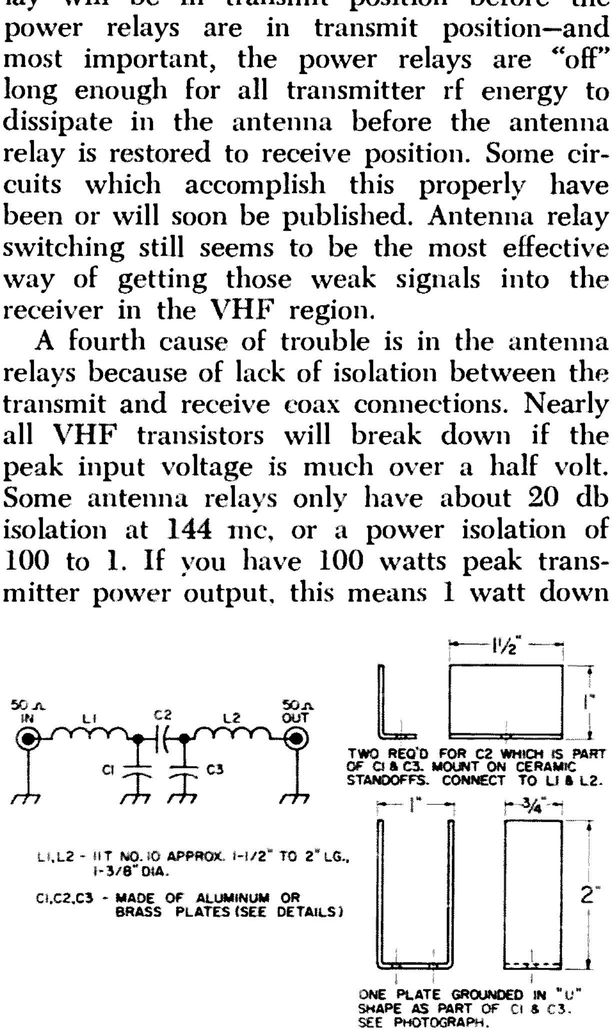


Fig. 1. 50 mc antenna coupler or filter.

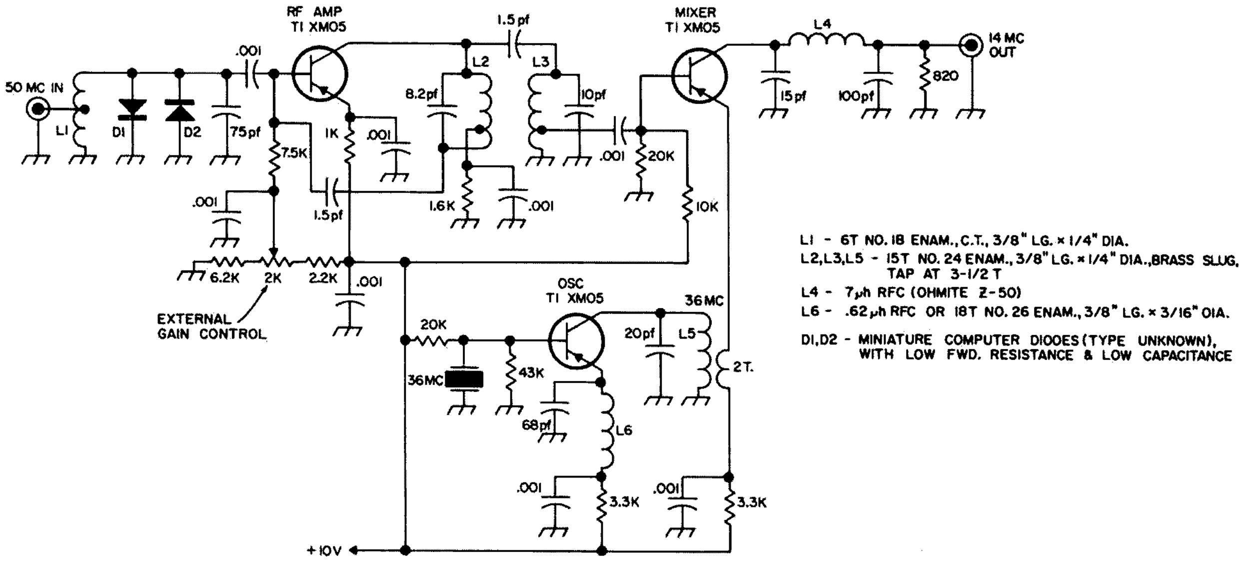


Fig. 2. Low noise 50 mc converter. The transistors are 52¢ TI-XMO5's.

into the receiver front end or about 7 volts peak across a 50 ohm circuit. Scratch one transistor! If your antenna relay has 50 db isolation in terms of power, then a KW of peak power would only put .7 volt into the receiver and the transistor might survive. Buy expensive coax relays that have good isolation especially if you operate with high power at 432 mc where antenna relays really lose db's of isolation.

About this time someone always asks why use transistors when tubes will cure this problem in the receiver front ends. The answer is that a recent transistor costing about 52 cents will have a better noise figure than tubes costing 10 to 100 times as much. A lower NF always means more readable signals except perhaps in areas of high man-made noise. Even in high noise level locations, a low NF receiver and noise blanker system will help as compared to the usual NF of a few db higher in the receiver front end.

Antenna relay lack of good receive-transmit isolation can be overcome to some extent by connecting two diodes of low forward resistance, back to back across the input circuit of a transistor. The two diodes should be of a fast type, preferably silicon rather than germanium, with low capacitance such as computor diodes. These two diodes will add a little capacitance to the circuit which can usually be tuned out. The signal loss at microvolt levels is usually quite small and their low resistance characteristics only become apparent at high levels when protection is needed against transmitters or distant thunder storms. Even good computor diodes can be burned out but only at levels many times greater than for a VHF transistor. Occasional checks are needed to ensure that these diodes in a circuit are still in operating condition. A soldering iron, long-nose pliers and an ohmmeter are the necessary test equipment for this purpose. Also be sure to isolate the transistor bias circuits from these two diodes with a small bypass coupling condenser. They should always be connected across a coil only, with one cathode and one anode to each end of the coil in order to short circuit high amplitude positive and negative rf pulses.

50 mc antenna coupler

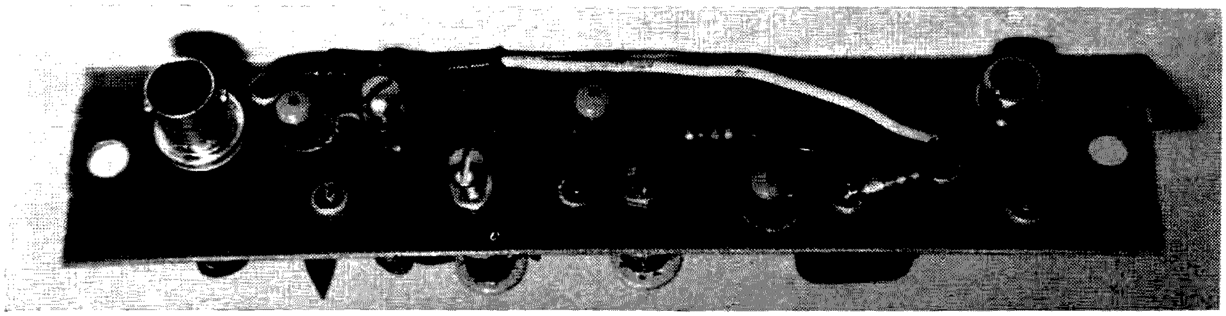
The circuits and ideas described previously, were incorporated into four transistor converters and the dual circuit antenna couplers for 50, 144, 220 and 432 mc. The 50 mc units are shown in this article with a follow-up for the other band units. The antenna circuit was the result of a number of different dual circuit units at 50 mc. The system shown had the least heat loss for transmitting and the least loss for receiving of any of the more usual forms such as tapped coils with variable tuning condensers, etc. The input and output coax connectors are in series with each coil which is part of a low C resonant circuit. With the values of C and L chosen, the loaded Q of each circuit is between 15 and 20 which is ample for covering about 2 mc of the 50 mc band. More coil turns and less capacity at the high impedance ends will increase the Q for 50 ohm input and output connections, with a narrower band-width. The tuning condensers C_1 and C_3 of **Fig. 1** and the coupling capacitor C_2 are made of two small plates of aluminum

or brass mounted on 1" x ½" or 1½" x ½" ceramic insulators. The grounded plate of C_1 and C_3 consists of a U shaped bracket of similar metal bolted to the chassis. The insulated plates were each 1½" square with ½" of one side bent at about right angles for mounting on the ceramic insulators. Bending these two plates towards each other increases C_2, the coupling capacity between the two tuned circuits. Bending the grounded U piece sides towards the insulated plates increases C_1 and C_3 and vice versa. Working the coil turns closer together increases L_1 or L_2. All these adjustments can be made when the mounting plate cover is in place since it was made of perforated Reynolds sheet aluminum. A 5 x 10 x 3 inch aluminum chassis (recovered from another project) was used to enclose the circuits. The circuits were tuned up before the whole unit was fastened to the chassis with numerous sheet metal screws.

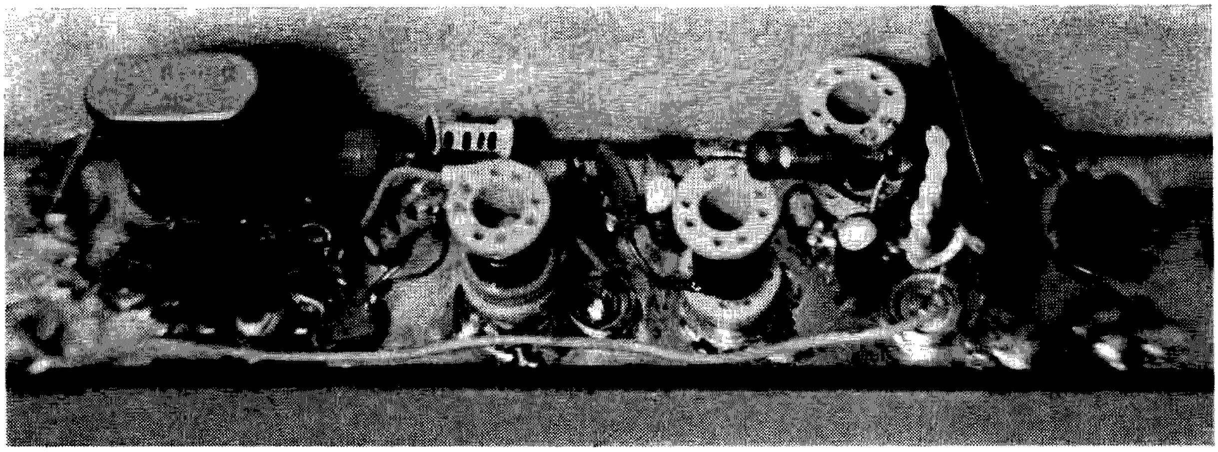
The tune-up can be done by shorting the coax fittings with a short piece of wire and grid dipping the coils to about 53 or 54 mc with the cover removed, shorting each coil not being adjusted. The next step consists of using a SWR power meter with a transmitter set for 50½ or 51 mc and with the chassis cover in plate. The transmitter is adjusted for maximum power output (plate circuit resonance, etc.) and the SWR reading noted for connection of the antenna feeder directly to the transmitter. The power reading should be noted also for a given value of plate current. Connect the dual circuit coupler between the antenna feeder and the antenna coax relay with the RG-8U coax. The coil lengths and C_1, C_2, C_3 plate spacings can then be adjusted in steps with a thin screw driver thru the perforated cover plate holes. The SWR meter on the antenna side of the coupler can be watched for maximum power reading with the same SWR reading as before. If you are lucky enough to have two SWR meters, put one on the transmitter side of the coupler and make sure it reads unity SWR by adjusting the final plate circuit condensers and the antenna coupler circuits. The final objective is to have unity SWR between the transmitter and coupler with nearly identical power readings into and out of the coupler. The output SWR will depend on the antenna matching at the antenna, not on coupler adjustments. An hour's work or less should result in, for example, 200 watts into the coupler and 185 watts output. For 90% or so of this time, use a large 50 ohm dummy antenna since the beam antenna should only be used for radiating intelligible signals, not as a general test instrument. Once the coupler or "filter" is properly adjusted, mount it in some out of the way place and forget it. It is intended for use on both transmitting and receiving and will add as much as 50 db of image suppression to the 50 mc converter and also reduce reception of unwanted signals outside of the amateur band.

Six meter converter

The 50 mc converter shown in the photographs and in **Fig. 2** was recently built and has a lower NF than other 50 mc converters in use at W6AJF. The new TIXMO5 transistors presently available from Texas Instruments at about 52 cents apiece are very excellent for use at any frequency from 14 to 432 mc. The only disadvantage is that the "plastic" casing cracks easily so either solder them into the circuit carefully or use the new TO-18 type transistor sockets which will fit these tiny transistors. The writer broke several TIXMO5 transistors trying out several in the rf stages of the 50, 144, 220 and 432 converters. In all stages except the input rf stage, these transistors can be soldered into the circuit using a very small soldering iron and supporting each lead with long-nosed pliers as each is soldered to the other circuit components. A small transistor socket is advisable in the first rf stage of any converter since



Top view of 2 x 6 inch board with BNC coax input jack and phono jack output. Unit mounts in 6 x 17 inch chassis for shielding slong with numerous other converters and switching panel.



Bottom view; copper clad side of converter.

this unit determines the NF and may need changing in time, after a few thunder storms in the area, or transmitter overloads. The input circuit in **Fig. 2** should only be used when the matching antenna "filter" is to be used in order to have good front end selectivity. The loaded Q of the input circuit is about 5 resulting in optimum NF but very little selectivity.

The rf stage is neutralized partially and forward gain control on this transistor permits reduction of rf gain without strong signal overloading and loss of noise figure. Forward gain control actually increases the transistor collector current flow to produce a reduction of gain. The collector series resistor reduces the collector dc voltage at a rate fast enough to reduce the stage gain even though the collector current is increasing. Normal gain control reduces collector current to reduce gain with fixed dc supply voltage. This causes a fast increase of NF and increases the rf stage cross-modulation problems on strong signals many times as compared to forward gain control.

The 10 volt and gain control leads were brought out thru 1000 pf solder-in feedthru capacitors. These same capacitors were used for other by-pass condensers with some resistors mounted on the insulated side of the 2 x 6 inch copper clad board. The slug coil forms were tapped out for a 6-32 brass machine screw which became the "tuning slug." Normally coils of this type come with regular adjustable brass slugs or with coded ferrite slugs (white for above 30 mc.) If ferrite slugs are used, reduce the coil turns about 15% or to about 12 turns in the same winding space.

The mixer stage with base signal input and oscillator injection into the emitter, has large enough coupling and by-pass condensers to act as fairly low impedance to the *if* output frequencies of 14 to 16 mc. The pi network from collector to 75 ohm output jack tunes broadly to around 15 or 16 mc with a 7 μh Ohmite Z500 rf choke and a couple of fixed ceramic condensers of the values shown in **Fig. 2.** This mixer circuit has very high conversion gain with nearly any good VHF transistor.

The 36 mc overtone crystal oscillator has a semi-tuned emitter circuit which is resonant between the 36 mc desired frequency and the crystal fundamental of 12 mc. This gives regeneration to the oscillator so it will oscillate at the 36 mc. frequency only when the collector circuit is tuned near 36 mc.

A noise generator is useful in tuning the interstage slug coils and the input coil turn spacing. A reasonably good noise generator showed a NF of 2.0 db at 50 and 51 mc and 2.3 db at 52 mc. This should be fine for the really choice dx when the F-2 layer opens up again or at the present time for double hop sporadic E openings.

The 144, 220 and 432 mc converters and a different form of dual circuit low loss antenna coupler for each band will be described in the next article.

. . . W6AJF

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Stanford, Cal. 94305

N-Channel FET's: RF Applications

Another 73 scoop: low noise, low crossmodulation transistor VHF RF amplifiers.

Occasional cryptic mention has been made recently in 73 of the Texas Instruments 2N3823, an N-channel field-effect transistor capable of excellent RF amplifier and mixer operation to 500 mc. This article will describe the advantages, disadvantages, and applications of this and similar devices for amateur use.

The operation of the FET has been described by WA6BSO (73, December 1965). Electrically it is similar to a vacuum-tube pentode, with high input and output impedances. The greatest advantage of the FET over tubes and transistors for RF use is its virtual immunity to cross-modulation—amplitude modulation of a desired signal by a strong interfering signal at an unrelated frequency, sometimes known as "riding in." Transistors are notoriously susceptible to this sort of interference. As long as the gate of the FET is neither driven sufficiently positive to conduct nor so far negative that the FET cuts off, the cross-modulation will be negligible. In practice the 2N3823 will handle interfering signals up to several tenths of a volt rms before cross-modulation of weak signals becomes even measurable.

The 2N3823 is also a low-noise device, with a noise figure typically 1.4 db below 100 mc. The typical noise figure of a 500 mc amplifier using the 2N3823 in grounded-gate, near the high-frequency limit of the device, is 4.5 db. However, there are transistors available that will do as well as this and which cost considerably less.

The FET will not be particularly resistant to intermodulation interference—the mixing of two strong signals to cause an interfering signal at the sum or difference frequency. This sort of interference is less of a problem because it occurs at specific frequencies, rather than everywhere in a band. In this respect the FET is neither much better nor much worse than tubes or transistors.

Fig. 1, 2, and 3 show the 2N3823 in the most common RF amplifier configurations: grounded source, cascode, and grounded gate. The grounded source amplifier will provide good gain and noise figure through 50 mc, but tends to be unstable with high load impedances; the feedback capacity is about 1.6 pf, compared to small fractions of a picofarad for pentodes. Output impedance is around 50K ohms below 300 mc, so high impedance loads can be used with no degradation of Q. Highest gain is obtained with high signal-source impedance, up to 10K ohms; best noise figure is obtained with a 1000 ohm source impedance; cross-modulation can be minimized with lower source impedance, (lower input voltage

Jack is now a student at Stanford working on his MSEE; he formerly was with TI, where he worked on the development of the 2N3823.

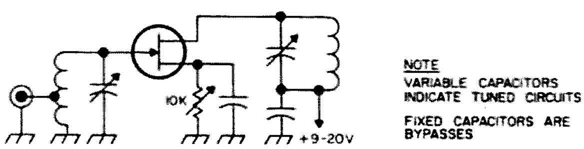


Fig. 1. Grounded source RF amplifier.

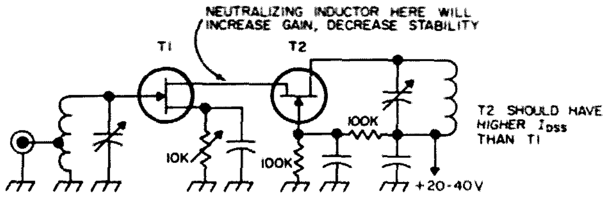


Fig. 2. FET cascode RF amplifier.

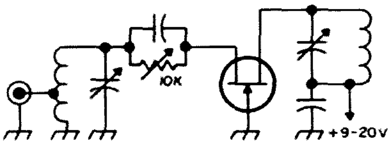


Fig. 3. Grounded gate RF amplifier.

step-up), limited of course by gain requirements. The cascode circuit is more stable, since the grounded source first stage is driving the low impedance grounded gate second stage. It has the obvious disadvantage of using two of these expensive devices.

Probably the best RF amplifier configuration for all frequencies is the grounded gate. The optimum source impedance for both highest gain and best noise figure is about 100 ohms. Since cross-modulation is caused by excessive gate-to-source voltage, the low impedance level gives better signal-handling capability. The 2N3823 in this circuit is stable and requires no neutralization through 500 mc. Power gain is between 15 and 20 db. Output impedance is above 50K ohms through 500 mc.

For each circuit, highest gain and best noise figure are obtained at zero gate source bias. Because of the P-N junction contact potential, the zero-biased FET will handle signals up to a few tenths of a volt before gate conduction becomes appreciable. For best resistance to cross-modulation, the FET should be biased so that the gate-source DC voltage is half the cutoff voltage.

To prevent cross-modulation in later stages in the receiver, interfering signals must be attenuated by tuned circuits before reaching stages capable of causing cross-modulation. If the FET RF amplifier is followed by a mixer susceptible to cross-modulation, and the intervening tuned circuits are not capable of lowering the interfering-signal amplitude sufficiently for the mixer to handle the signals, the advantage of the FET will be lost. Hence the desirability of an FET mixer. Any of the usual vacuum-tube circuits (other than those using screen-grid injection) can be used; **Fig. 4** shows a typical circuit. For maximum conversion gain, the local-oscillator voltage should be close to one-half the FET cutoff voltage (peak) with the mixer biased to half the cutoff voltage. However, for good resistance to cross-modulation, the instantaneous sum of oscillator voltage and signal voltage should neither drive the gate into conduction nor cut off the FET. Hence it is mandatory that the local-oscillator voltage be as low as is practical, at the expense of conversion gain and noise figure. High-selectivity tuned circuits can then cut down interfering signals to minimize cross-modulation in the IF stages.

While all FET's will provide the high resistance to cross-modulation of the 2N3823, there is no other FET capable of equalling the 2N3823's low-noise high-gain VHF performance. The greatest disadvantage of the 2N3823 is the price: $12.90. There is a less-expensive version, the TIS34, which is a 2N3823 in a plastic capsule and without guaranteed VHF specifications. A considerable part of the cost of the 2N3823 is in the testing of parameters. DC parameters can be tested very rapidly by machines; RF parameters have to be laboriously tested by human operators, an expensive process. The TIS34 sells for $7.80—still expensive, but a 40% savings. The 2N3823 guarantees a noise figure under 2.5 db at 100 mc, and transconductance minimum 3500 μmho at 100 mc. The probability that a TIS34 will provide RF characteristics equal to those of a 2N3823 is better than 90%.

Most of the competitive N-channel FET's have lower transconductance than the 2N3823, which will result in inferior noise figures. For applications below 50 mc some of these devices may do well enough to be below the atmospheric noise level. It has been stated that with respect to noise an FET is approximately equivalent to a pentode with 3½ times the transconductance of the FET. Devices fabricated at Texas Instruments with very high transconductance—15,000 μmhos and up—had inferior high-frequency performance. Apparently the 2N3823 has about the optimum geometry for RF applications.

Finally, if you intend to try out a TIS34, get a data sheet for the 2N3823 as well, since the latter has data and graphs not on the TIS34 data sheet.

. . . WA5KLY

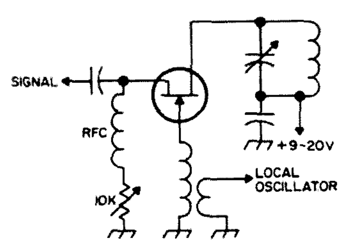
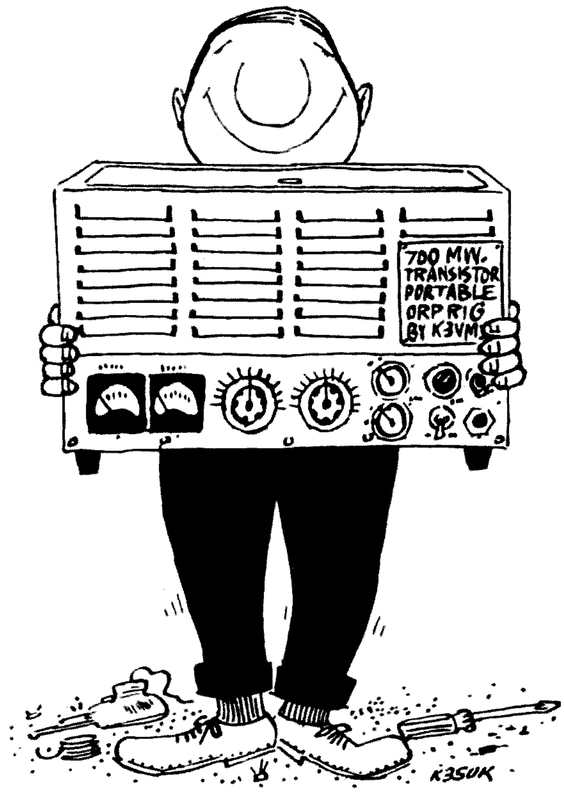


Fig. 4. FET mixer.

Dennis Ardinger K3VMZ
401 Maplewood Drive
McMurray, Pa. 15317

Size is Impressive



Shakily I sat at the operating position and gleamed at my months of hard work of scrimping and scrounging. My first construction project was completed . . . a code practice oscillator.

With the help of a friend I pushed the cpo into the corner.

I told myself this was the end. I had proved to myself I could build something that I needed in the hamshack. But it was no use, the bug had bitten. I must now advance to harder and more classy projects.

Shuffling a 73 out of my precious box of moldy radio magazines, I leafed through it for something even I could build. I wanted something that was a challenge, but not impossible. Something that was impressive, but didn't have too many of those little carbon or paper things.

There it was. My hearts desire. A QRP transmitter for portable operation. A solid 700 milliwatts! And it had impressive milliamp meters with it too!

Carefully checking the parts list, I took note of what I had and what I needed. I was really going to do a neat job on this one I kept telling myself.

The rig required a 4x4x6 inch aluminum box. Ah—this old TV chassis would do the trick. "Build it breadboard fashion" I thought. Spread the parts around and give the 2N697 transistors plenty of space to dissipate all that choking heat they build up. "After all" I thought, "It has to be open to show friends the technical advancement of us modern hams."

In the weeks that followed my shack was turned into an anthill of filing, soldering, bolting, testing and retesting. By now I could even tell what all the symbols on the schematic meant without having to look in the *Handbook*. I could now identify the emitter, collector and the base on the transistors. I was in my days of glory!

I was careful to select very stylish venier dials for the variables. Then I decided to go highhat and completely enclose my pride and joy in a metal cabinet. The local radio store had just the one I needed—a 9x22x15 inch steel cover that cost me just under $15.

Several weeks later, after I had completed my "Emily" as I named her, and even made a contact, I got to wondering if high power would give me better results. After all, taking the transmitter with me everywhere I went was silly . . . I didn't have a portable receiver. Besides, the XYL complained about no leg room.

Once again I carefully consulted my technical library of literature and came up with a 10 watt rig for mobile use. Well that almost brings me up to date. With the car sold to provide money for the parts and the one wall of the garage turned into a giant chassis, I am almost ready to begin another tinkering job.

Now where did I put that article about advancements in miniaturization?

. . . K3VMZ

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FSK Principles

One of the simplest problems that faces the new RTTY'er is adapting his transmitter to FSK. Strangely enough, this job seems to be a stumbling block for many. This article will cover the principles of one of the simplest and most widely used methods for frequency shift keying. Also, methods for obtaining local copy while transmitting will be discussed.

Basic principles

In order to transmit RTTY signals, the transmitter frequency is shifted between two different frequencies. The standard method for amateur use is to use the higher frequency for MARK and the lower frequency for SPACE. Remember; "LSMFT"–Low Space Means Fine Teletyping! The standard shift for amateur and MARS use is 850 cps. The FCC requires the shift to be less than 900 cps and many amateurs are experimenting with narrow shifts as low as 100 cps.

The basic idea in shifting a transmitter is to cause the keyboard to switch a reactance in and out of the oscillator circuit in such a manner as to change its frequency. While this reactance can be either an inductance or a capacitance, capacitors are usually used since they are cheaper and have lower loss. To obtain the space, or lower frequency, the capacity is switched across the tuned circuit in a VFO or the crystal in a crystal oscillator. For the mark signal, the capacitor is switched out of the circuit. It would be very difficult to do this switching mechanically so some type of electronic switching is generally used. A diode makes a very simple and effective electronic switch. By reverse biasing the diode, it looks like an open circuit and by applying a large forward bias, it looks like a short circuit. If the forward bias current is made small, the diode will look like a resistor instead of a short circuit. Thus, by varying the bias, we have an electronically controlled resistance! The switching from reverse to forward bias

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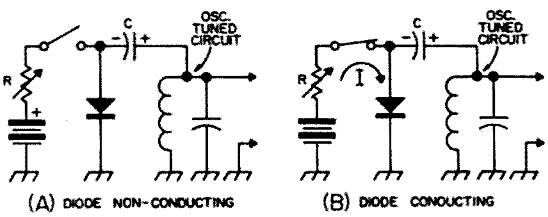

Fig. 1. Simplified diode FSK circuit.

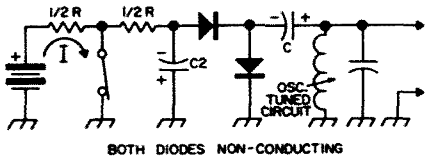

Fig. 2. Simplified diode FSK circuit for "space-low" condition.

can be done remotely by the teletypewriter keyboard.

Fig. 1 shows a very simplified version of a diode FSK circuit which will illustrate how this can be done. **Fig. 1a** would be the high frequency condition and **Fig. 1b** would be the low frequency condition.

When the key is open, as in **Fig. 1a,** the RF voltage present at the oscillator tank circuit is rectified by the diode, causing the capacitor C to charge up to the polarity shown. This negative bias on the diode causes it to be reversed biased and to look like an open circuit. Thus, the capacitor C is effectively disconnected from the tank circuit and the frequency is determined by the oscillator tuning capacitor. In **Fig. 1b,** the key is closed and the diode coducts due to the external battery. The resistor R controls the current I through the diode and consequently controls the effective resistance of the diode. The diode is a non-linear device; that is, the current through the diode does not change in proportion to the voltage across it. Due to this characteristic, effective resistance of the diode (the ratio of the incremental voltage across the diode to the incremental current through the diode) will change as the dc current through the diode is varied. If this dc current is large, the diode resistance will be very small and the full capacity C is connected across the oscillator tank, lowering its frequency a maximum amount. If the dc current is reduced by increasing R, the diode resistance is increased and a smaller amount of capacitance is effectively across the tuned circuit and the frequency shift is less.

You may notice one difficulty with the circuit shown. If the key represents the keyboard, then the low frequency would be for the keyboard contacts closed (MARK condition). However, we want the SPACE to be the low frequency. Also, when the key is open, the leads from the diode to the keyboard are "floating" and might cause trouble with hum pickup. To solve these problems, a circuit shown in simplified form in **Fig. 2** is used. In this circuit, the key when closed cuts off the diode current by bypassing it to ground. A second diode in series will become reverse biased due to a charge built up on C_2 which completely isolates the external keying circuit from the oscillator. If shielded leads are used from the diodes to the external keyboard, etc., little trouble with hum or noise pickup should be encountered. When the key is open, forward dc current can flow through both diodes as before, producing the desired low space frequency.

Practical FSK circuits

The FSK circuits shown above are quite simple but there are a few practical problems which need to be considered. The first problem involves the choice of diodes. Vacuum tube diodes are very well suited and are stable and reliable. The 6AL5 and 12AL5 miniature types are commonly used although the 6H6 and 12H6 are often used in surplus VFO's such as the ARC 5 series. Of course, heater power must be supplied to these diodes. Many of the point-contact germanium diodes work very well if simple precautions are taken. One of the best types is the IN100 (or IN99) which has a very high back resistance and is very small. However, the more common IN69, 1N34A, and similar types will do a very good job. Junction diodes, such as silicon power rectifiers are not too satisfactory due to their high junction capacitance when reverse biased.

The second problem is that of eliminating "key clicks" which can produce excessive interference just as in CW. The problem is easily solved by using a simple RC network to soften or slow the transition from MARK to SPACE.

A simple circuit which fulfills these requirements and is easily built is shown in **Fig. 3.** It can be added to almost any VFO and provides smooth, stable frequency shift. In this circuit, the normally-closed keyboard removes the voltage from the diodes and the capacitance C is effectively disconnected from the oscillator. Note that this capacitor which produces the desired frequency shift is connected to the VFO cathode, since this is a relatively low impedance point. Most modern oscillator circuits have their cathodes above ground for RF. If

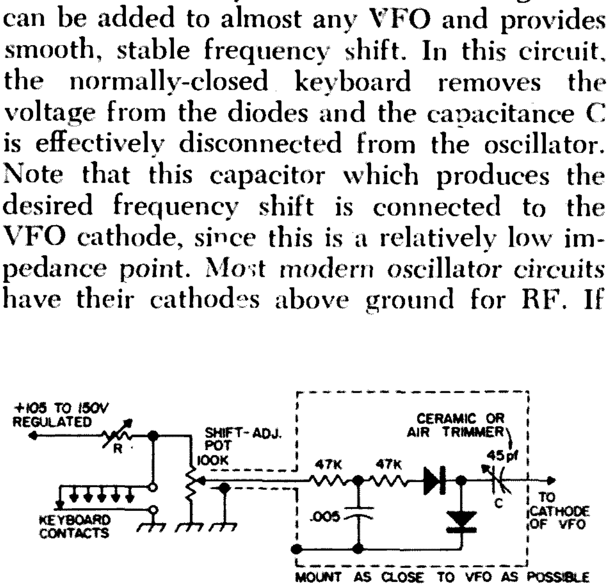

Fig. 3. Simple, practical FSK circuit.

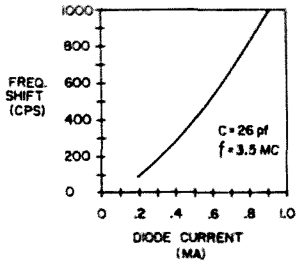

Fig. 4. Typical variation in shift with diode circuit.

this isn't the case in your VFO, you can tap the VFO coil a few turns from the ground end. When the keyboard is opened, the diodes conduct partially due to the forward diode current which flows. This causes a portion of the capacity C to appear in the VFO circuit, lowering the oscillator frequency for the space signal. The 47k resistor and .005 µf capacitor act as the key-click filter since the RC charge time causes a gradual frequency shift (about 1 ms) rather than an abrupt shift. Similarly, when the keyboard closes, the gradual discharge of the RC circuit softens the shift back to MARK.

The part of the circuit shown in dotted lines should be mounted as close to the VFO tube as possible. Many VFOs will have room to mount a tie-point strip with the components shown right in their shield cans. To avoid a permanent modification of a VFO, the circuit can be built in a small shield box mounted near the VFO and the connection to the tube cathode made by wrapping a small piece of solid hook-up wire around the cathode pin. The shift adjustment pot may be mounted externally from the transmitter if desired. It can be on the RTTY converter panel or near the keyboard. A shielded lead to the pot is recommended to prevent noise and hum pickup.

The value of the dropping resistor R will depend on the value of the regulated voltage you have available. This circuit draws only a milliampere or so from this voltage source so this can usually be obtained from a VR tube already in the transmitter or the RTTY converter, or one can be added to any convenient power supply. The following initial adjustment procedure is suggested. Choose R to provide about 50 volts at the top of the shift pot with the keyboard "open." Now with the pot wiper at the top, adjust trimmer (shift capacitance) C for slightly more than 850 cps shift on the lowest frequency band to be used. If insufficient shift is obtained with maximum C, either decrease R to get more diode conduction or parallel C with a small mica capacitor. When proper shift is obtained on the lowest frequency band, the shift can be reduced by use of the shift adjust pot for higher frequency bands where the oscillator frequency is multiplied. To illustrate the effect of varying the diode current with the pot, **Fig. 4** shows the frequency shift vs. diode current for a Heathkit VFO using this circuit with 1N69 diodes at 3600 kc.

Shifting crystal oscillators

Many crystals can be successfully shifted 850 cps using diode shifters. However, some will quit oscillating before sufficient shift can be obtained. The circuit shown for VFO's can be used with slight changes. The shift capacitor C is connected to the oscillator grid and the shift pot is eliminated. Sufficient current is bled through the diodes to cause them to conduct completely instead of partially. Thus the diodes are acting as switches instead of variable resistors. The shift capacitor C is adjusted to obtain proper shift. Most existing crystal oscillators will be found to be unsatisfactory for shifting due to high fixed capacity across the crystal circuit. It is better to build a new oscillator taking great care to keep stray capacity down, such as using very short leads in grid circuit, etc. A high gm tube such as a 6AK5 is the best choice. The disadvantage of the crystal-FSK circuit is that usually there is no margin for zeroing-in on a net frequency since all possible "pulling" needs to be utilized for shifting. It is possible to adapt the VO circuit that is popular for mobile SSB rigs to provide a tunable crystal-FSK circuit.

Obtaining local copy

When transmitting FSK with the circuit of Fig. 3, the keyboard operates only the FSK circuit and does not print "local copy." To monitor what you are transmitting, it is necessary to tune your receiver exactly to your transmitter and to allow the RTTY converter to operate the printer. The receiver gain must

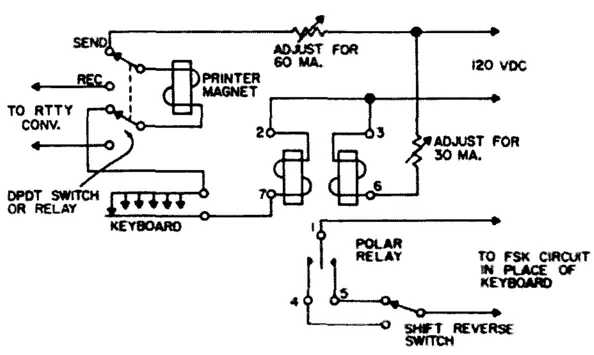

Fig. 5. Recommended keying circuit to obtain local loop copy.

be reduced to prevent overload. While this method allows continuous monitoring of the transmitted signals, there are some drawbacks. Beside the obvious difficulties in switching receiver gain and returning in case the other station is not right on your frequency, there is a problem in keeping the keyboard contacts clean. These contacts are subject to collection of an oil film along with dust and dirt. In the FSK circuit, they break only about 1 ma of current. This is not sufficient to keep this film "burnt off" as is the case when the 60 ma magnet current is being interrupted. Also, all spark-suppression filters must be removed from the keyboard circuit when driving the FSK direct or these will cause bias distortion. Then these filters are not available for local loop operation.

A method which gets rid of these problems is to operate the keyboard and printer in series in a local 60 ma loop along with a polar relay. The relay contacts then repeat the keyboard pulses to the FSK circuit and the printer provides direct local copy. A polar relay is used rather than an ordinary single-coil relay which would cause pulse distortion due to its different pull-in and release currents. The circuit shown in Fig. 5 is a simple way of using this method.

A DPDT send-receive switch (or relay operated from transmitter S-R relay) changes the printer magnets from the converter for receiving to the local loop for transmitting. With some converters, the polar relay and keyboard can be permanently connected into the printer loop and the keyer tube circuit can supply local loop current for transmitting by means of a "hold" switch or relay. In mounting a polar relay, be certain to mount either vertically, or if horizontally, so that the relay armature moves in a horizontal plane.

The relay contacts are enclosed and free from dust and dirt. Clean frequency shift keying is easy to obtain. Another advantage of this method is that it allows the shift to be easily reversed by means of an SPDT switch. This feature is needed for some transmitters using heterodyne VFO's where the upper beat frequency is used on some bands and the lower beat on other bands.

Summary

Adapting a transmitter to FSK is one of the simplest and easiest jobs in getting on the air with RTTY. If you see the principles involved, the construction and adjustment of the FSK circuit should prove very straightforward.

. . . W4EHU

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Build this simple adapter for low-cost panoramic display of the VHF and UHF bands.

Panoramic Reception for VHF-UHF

The serious VHF-UHF operator is interested in what's going on over a relatively large frequency spectrum. A panoramic receiver of some type can be a great help.

Usually the adapter scans the *if* of the receiver and displays what is present in the *if* passband on the face of a cathode ray tube. As the receiver is tuned in this case, the display moves, with the signal heard in the speaker being displayed in the center of the CRT. However, the range of frequencies seen on the screen at any one time is about 100 kc or less due to the selectivity of the receiver *if* system and/or the front end selectivity. If the receiver is left tuned to one spot on the VHF band, only 50 kc each side of that point is visible on the CRT. That's not much range compared to the limits of any VHF or UHF band.

There are other methods of obtaining panoramic displays and the following is a description of a usable unit. This simple gadget will allow a standard oscilloscope to be used as the screen. In addition it will allow a much larger portion of the band to be observed at one time, in fact *all* of the band in some cases. The amount of band viewed is variable and one "pip" or signal can be centered and "blown up" to check modulation and to be heard in the receiver speaker. In this case the spectrum viewed is just the band width of the receiver.

A dual triode is connected as a sawtooth or sweep generator just like the one in an oscilloscope. The output of this is fed thru a level control to the horizontal input of a regular oscilloscope. This control varies the width of the display and doesn't affect the frequency range. This same sawtooth waveform is also fed thru another level control to a voltage variable capacitor or varicap, diode. This diode is in the frequency determining circuit of a triode rf oscillator. This local oscillator is set up on the same frequency as the oscillator in the receiver or converter used. When the sawtooth voltage gets to the varicap, the oscillator changes frequency in step with the spot going across the scope tube face. Meanwhile the vertical circuit in the scope is looking at the receiver *if* output and when a signal appears it causes the spot to be deflected vertically. Thus, for each signal, a "pip" appears on the scope base line to indicate a signal, the frequency of this signal can be determined by its relative position from left to right. Since the sweep for the spot and the local oscillator are from the same source and "in step" the pips will remain stationary. The level control in the varicap circuit becomes the band width control.

Ed is a self-employed communications equipment maintenance specialist and he also works on the family ranch. His main interest is VHF.

The pip can be *if* voltage or this voltage can be detected by a diode. **Fig. 1** shows the two methods and their resultant displays. In the case of looking at the *if* directly, the vertical

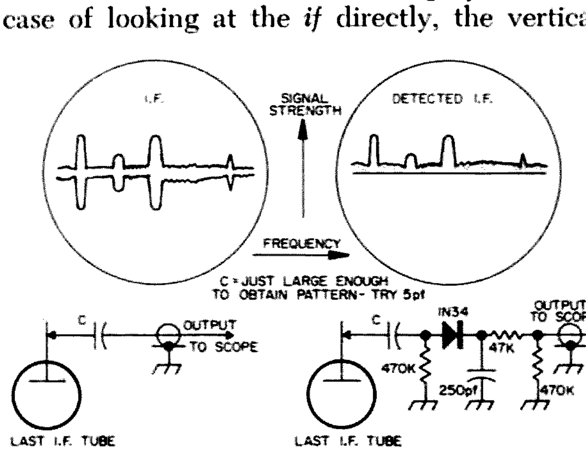


Fig. 1. Vertical scope connections to receiver.

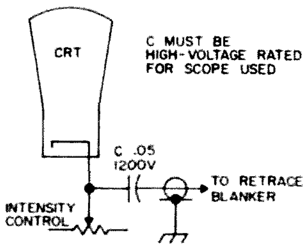


Fig. 2. Retrace blanking (optional).

amplifiers in the scope have to be capable of handling the *if* frequency. Many scopes will show up to 5 megacycles.

When the spot on the scope finishes its relatively slow trip from left to right across the screen, it has to come back to the starting place. Due to the rapid fall off of the sawtooth voltage from its peak value, this journey is made in much less time. The result is a dim line across the scope from right to left. Signals present in the vertical circuits at this time will be seen as dim "ghost" images, greatly widened because of the speed of the retrace. If the electron beam in the CRT can be cut off during this period, this retrace can be eliminated. If this is desired, a triode grounded grid circuit is included to feed a pulse from the cathode of the sawtooth oscillator to the CRT cathode in such a way as to bias it to cutoff at the right time. If the scope has a "Z" axis input connection this probably could be used. In the RCA WO33A used at this QTH a coupling capacitor was added in the scope from the cathode of the CRT to a phono socket on the front panel. The retrace blanking pulse is fed in here and puts a positive pulse on the CRT cathode at the right time to cut off the spot. This cathode has about 650 volts negative and the plate of the blanker a couple hundred positive, so better use a good pair of .1 µf at 600 volts in series or something better for the coupling capacitor.

The other half of the blanker is used as a buffer for the oscillator to isolate it from the receiver circuits. This also makes it possible to "swamp" the output of the adapter to keep from overdriving the receiver circuits.

Of course you will use small coax or shielded cable for all interconnections between scope, receiver and adapter. Parts layout is not critical, but keep lead lengths down and mount the RF parts solidly so calibration will hold.

The RF oscillator in the unit can be almost any type as long as it is capable of covering the desired frequency range. Extreme stability is not needed as a small frequency shift will not be noticeable if a large portion of the band is being scanned. With a given circuit, a high ratio of inductance to capacitance will

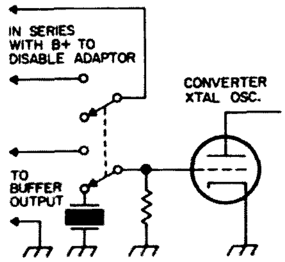


Fig. 3. Panadapter switching.

give the most frequency change with a given capacity change. A limit to this is reached when the "Q" of the circuit becomes too low to allow oscillation. Some types of diodes will have a lower "Q" and may be the limiting factor on the frequency range covered.

In the circuit shown, a regular power rectifier diode (silicon) is used as the varicap. One with a 400 to 750 volt peak inverse rating is adequate. Individual units will have somewhat different characteristics as to "Q", dc bias needed for a given capacity and capacity range available. Almost any will work but try a few if available and see if one of them might be better than the rest.

A regular varicap or varactor may be used but be careful not to exceed the piv rating. The circuit shown will exceed these ratings and should be modified at the "X" points in the high side of the diode bias control and the band width control. A suitable resistor may be inserted at these points to limit the voltage the controls may place across the diode. These resistors may run to several megohms. Leave out the diode until you have installed the resistors by trial and then run the controls all the way up and measure the dc bias with a VTVM and the sweep with your scope and be sure it isn't too much for the varactor you choose. This is not a problem with the power diodes used in the circuit as shown. More frequency range may be obtained with the varactors but other problems appear. The RF voltage at the grid can override the small bias used. A 100 pf at 4 volt diode tapped down on the coil between cathode and ground thru a 250 pf condensor with dc bias of about 4 volts (using 10 meg resistors in the "X" positions) will cover all of 2 meters

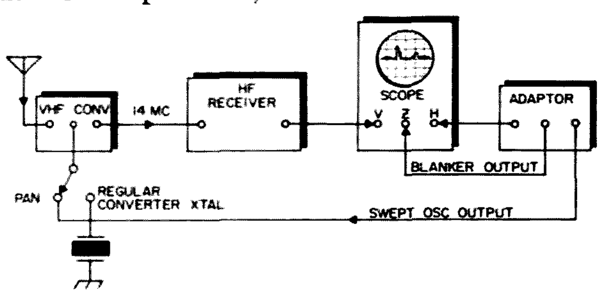


Fig. 4. Interconnection block diagram.

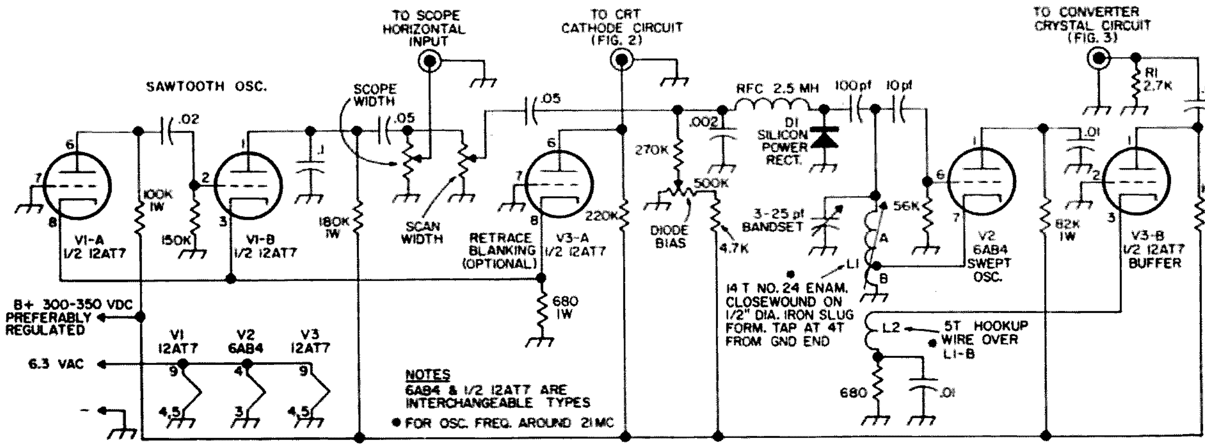


Fig. 5. Panadapter circuit.

easily when used as shown with a 2 meter convertor to a 14 mc receiver. As more band is covered it becomes more likely to get a spurious pip somewhere along the base line. Actually the power diodes are easier to work with in tube circuits and give plenty of frequency range. The low voltage high capacity diodes are ideal for use in transistor circuits. Those of you who believe the little rascals are here to stay could convert the circuit to a transistor operation.

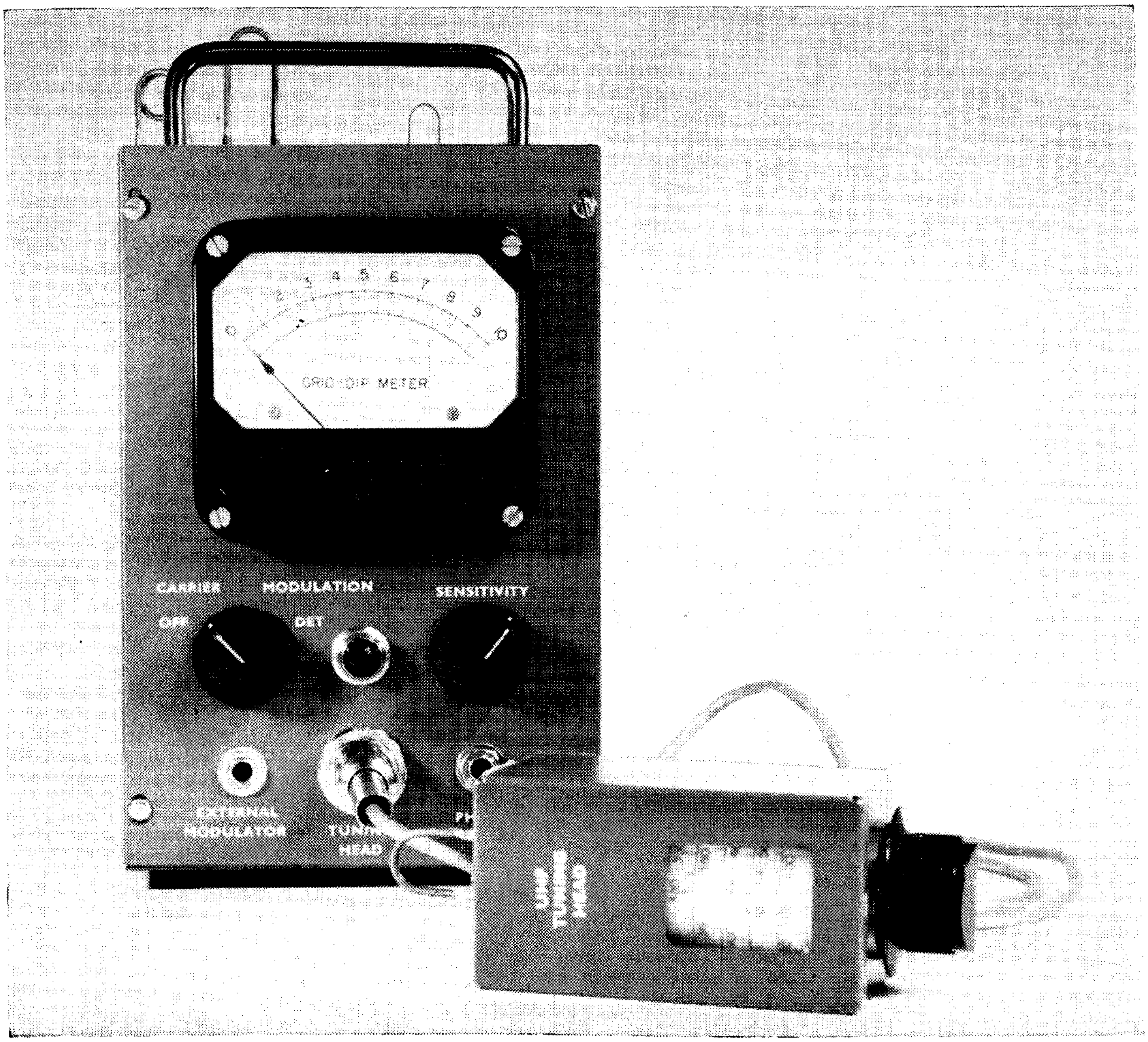
The frequency range of the oscillator will depend on the receiver or convertor it is to be used with. The injection may be made into the crystal socket of most converters and in this case it may be one half of the crystal operating frequency. An example is the much used 2 meter converter working into a 14 to 18 mc receiver. The crystal in these converters is usually marked 43.33 mc. The output of the crystal oscillator is tripled to 130 mc and the result of mixing this with 144 to 148 mc is the 14 to 18 mc you feed into your receiver. So if a sweep frequency of 21.66 to 22.33 mc is put in where the crystal was the result is a 144 to 148 mc sweep which comes out on 14 mc. Tune your receiver to 14 mc, connect up the scope and adapter and you will be looking at 144 to 148 on the CRT screen. Of course in this case you are getting 6 times multiplication of the sweep range by the multiplier chain in the converter. Resistor R1 across the output of the buffer is to keep the crystal oscillator from generating spurious frequencies due to overdrive. This resistor looks pretty low but even less can be used. If too much oscillator voltage gets across the large resistor in the crystal oscillator grid circuit the tube becomes a good harmonic generator and lots of strong "birdies" appear on the screen.

Another place to insert the sweep oscillator output is the mixer stage in the hf receiver. In this case not so much range is available because of the front end selectivity of the receiver. However from 14 to 14.5 can be covered with most receivers. This would give you 500 kc of any VHF band depending on which converter you switched to. Also coverage of twenty meters which is rumored to be still in operation.

In any case the unit should be arranged so it can be switched in and the regular tuning oscillator or crystal out and vice versa, with just the flick of one switch. The oscillator should be disabled when normal tuning is used to keep down any odd birdies that might appear.

A few things to keep in mind when building the unit to use with a particular receiving setup: The more range you cover, the less distance between pips and the less you can tell of their nature. If you put a fairly good dial on the bandset variable condensor in the oscillator you can center a pip and keep it centered while you reduce the sweep to zero and look at that signal alone and hear it in the speaker. On a dead VHF or UHF band a signal coming on will cause a low frequency note in the receiver speaker. Vary avc, bfo and volume settings for best results. If different selectivities are available on the receiver see which works best. If noise pulses from a 60 cycle source stand still on the screen, change the .1 μf condenser or the 180 k resistor in the sawtooth oscillator slightly so it will not sync with the noise. This will make it easier to distinguish between signals and power line noise. Turn the rf gain down so that noise is just visible on the base line. You can spot check with your own transmitter or exciter to determine the frequency range covered. Be sure and compare your ability to detect weak signals with the scope to results you get by listening to the speaker and manual tuning with the bfo on.

. . . W5NPD



Jim Fisk WA6BSO
1560 Glencrest Court
San Jose, California
Photos by Jim Harvey WA6IAK

UHF Grid Dipper

In answer to your pleas for complete plans for a good UHF grid dipper, WA6BSO has written his up. It covers 300-680 mc and you can even use a precalibrated dial if you follow his instructions carefully.

When building or testing equipment for the 420 mc band, amateurs invariably run into the problem of, "Where am I?". It becomes a little difficult to tell whether you are actually in the band or somewhere nearby. The uninitiated will counter that you should be able to figure close enough, after all the band is 30 mc wide; but even the experienced old timer will confirm that this just isn't so.

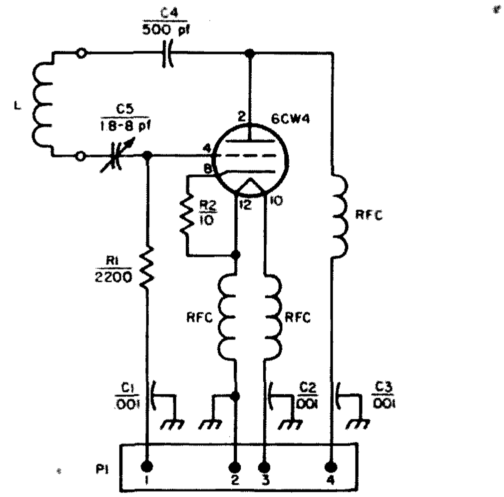
The 420-450 mc amateur band falls be-

tween the VHF and UHF television assignments and there is very little to use for a frequency reference point. It is nearly impossible to tell exactly where you are without resorting to expensive commercial gear or lecher wires. Nor is the problem confined to the ¾ meter band; when building crystal controlled converters for 432 or 1296, it's nice to know that the last tripler is really tripling and not doubling or quadrupling. Even with a 45 or 50 mc crystal, it's quite easy to tune up on the wrong harmonic. Remember that a 40 mc change at 400 mc is analogous to a 400 kc change on 75 meters.

There are several commercial instruments that fill this requirement nicely, but the cost of the least expensive of these would buy a pretty respectable all band receiver. Occasionally suitable test equipment appears on the surplus market, but again, the price is prohibitive. The simple UHF grid-dipper described in this article was designed specifically to economically fill this need. It covers the frequencies from 300 to 680 mc at a total cost that is comparable to a low-frequency kit-type grid-dipper. By using junk-box parts and smart horsetradesmanship this cost may be substantially reduced. I should hasten to point out that substitution of parts in the tuning head should be avoided if accurate dial calibration is desired.

This particular grid-dipper has been duplicated several times and in each case calibration has been within several percent of the original unit; at least as accurate as the familiar kit-type grid-dipper. This is helpful to the ham who does not have access to commercial equipment for calibration purposes. By using the layout and parts described in this article, the precalibrated dial illustrated in **Fig. 8** may be used with a minimum of error.

Although an accessory power supply, modulator and indicator are included in this design, an enterprising ham could use the power supply and meter presently available in any lower frequency tube type grid-dipper. Although us-



C1,C2,C3	STANDOFF BUTTON BYPASS CAPACITORS
C4	BUTTON CAPACITOR (SEE TEXT)
C5	E.F. JOHNSON TYPE 160-104 VARIABLE
L	PLUG-IN COIL
P1	AMPHENOL 91-MC4M MALE CABLE PLUG
RFC's	8-1/2" No 26 ENAMELED WIRE WOUND ON 1/2 W, 100 K COMPOSITION RESISTORS

Fig. 1. Schematic of the rf head of the UHF grid dipper.

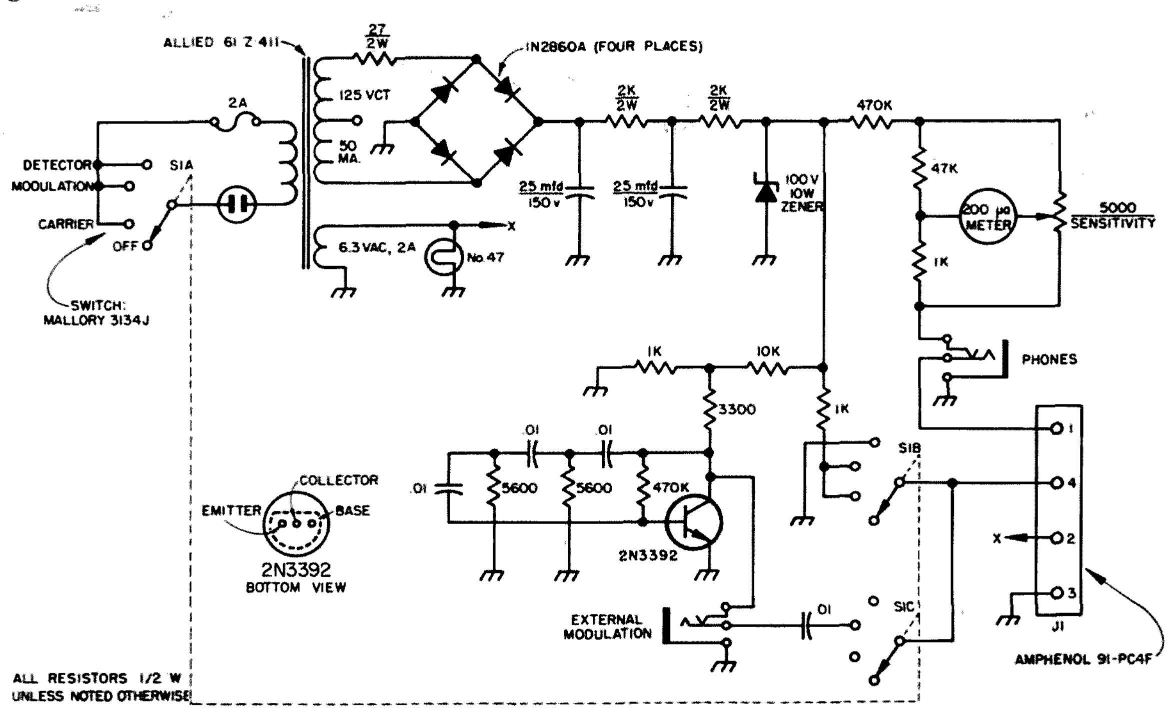
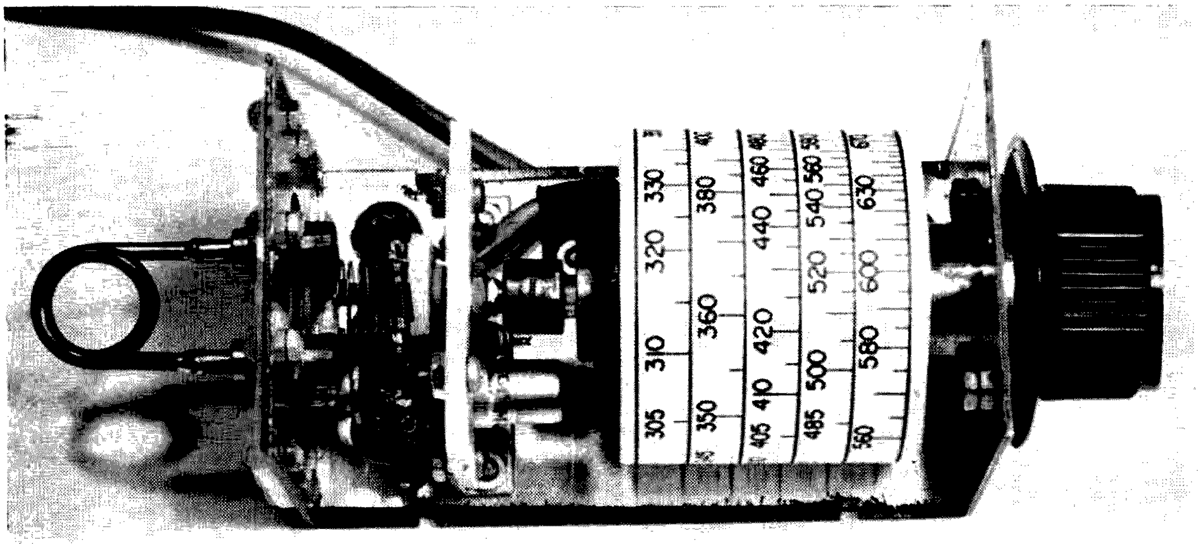


Fig. 2. Power supply and modulator for the UHF grid dipper.



ing a modified low-frequency dipper is simple and inexpensive, the power/indicator box specifically designed for the UHF tuning head has several features that are not available in inexpensive kit-type units. These include internal 1,000 cycle modulation, provision for external modulation, and voltage regulation which provides the necessary stability at the ultra high frequencies.

The rf tuning head

The heart of this instrument lies in the tuning head itself. There is nothing particularly new or different about the circuit, but at these frequencies stray inductance and capacitance in circuit layout and construction will seriously affect the end result. All the lead lengths must be as short as humanly possible and physical circuit layout must follow standard UHF practice. One of the big problems in building tunable oscillators at UHF is to obtain an oscillator that will tune from one end of the range to the other with no "holes," frequency jumping or instability. The series tuned 6CW4 nuvistor oscillator shown in **Fig. 1** fills these requirements.

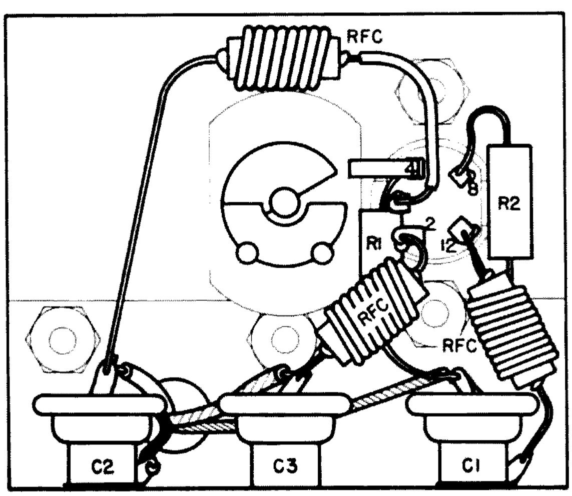


Fig. 3. Critical wiring around the 6CW4 socket.

Insofar as possible, all the tuning head wiring is done on a point-to-point basis with the components mounted directly to the 6CW4 tube socket or button capacitor lugs as illustrated in **Fig. 3**. To obtain the desired accuracy with the precalibrated dial, this diagram should be followed as closely as possible.

To keep stray circuit inductance to a minimum, all wiring between the coil and tube socket is done with one-quarter inch wide strips of thin copper sheet. In addition, the rotor of the variable capacitor is connected to the 6CW4 grid (pin 4) with a short strip of the same material. The only tricky part of this wiring is the installation of the series capacitor C4. This capacitor is a 500 picofarad button type mounted as shown in **Fig. 5.** The "S" shaped bracket ("A") is made from a one-quarter inch wide copper strip, one and one half inches long and soldered to the mounting stud of the capacitor. Connection to the 6CW4 plate (pin 2) is made with the soldering lug on top of the button.

Connection to the stator of the variable capacitor is accomplished with another short strip of thin copper as shown in **Fig. 5** ("B"). This piece of copper is bent so it touches both stator mounting pins when the unit is assembled; then it is soldered in place.

The oscillator and tuning mechanism are housed in a standard 2¼ × 2¼ × 4 inch chassis box laid out as shown in **Fig. 4.** Although the author's unit is based on an LMB type 107 chassis box, other manufacturers have similarly sized boxes which are equally suitable. The layout of the enclosure is straight-forward and no difficulty should be found in duplicat-

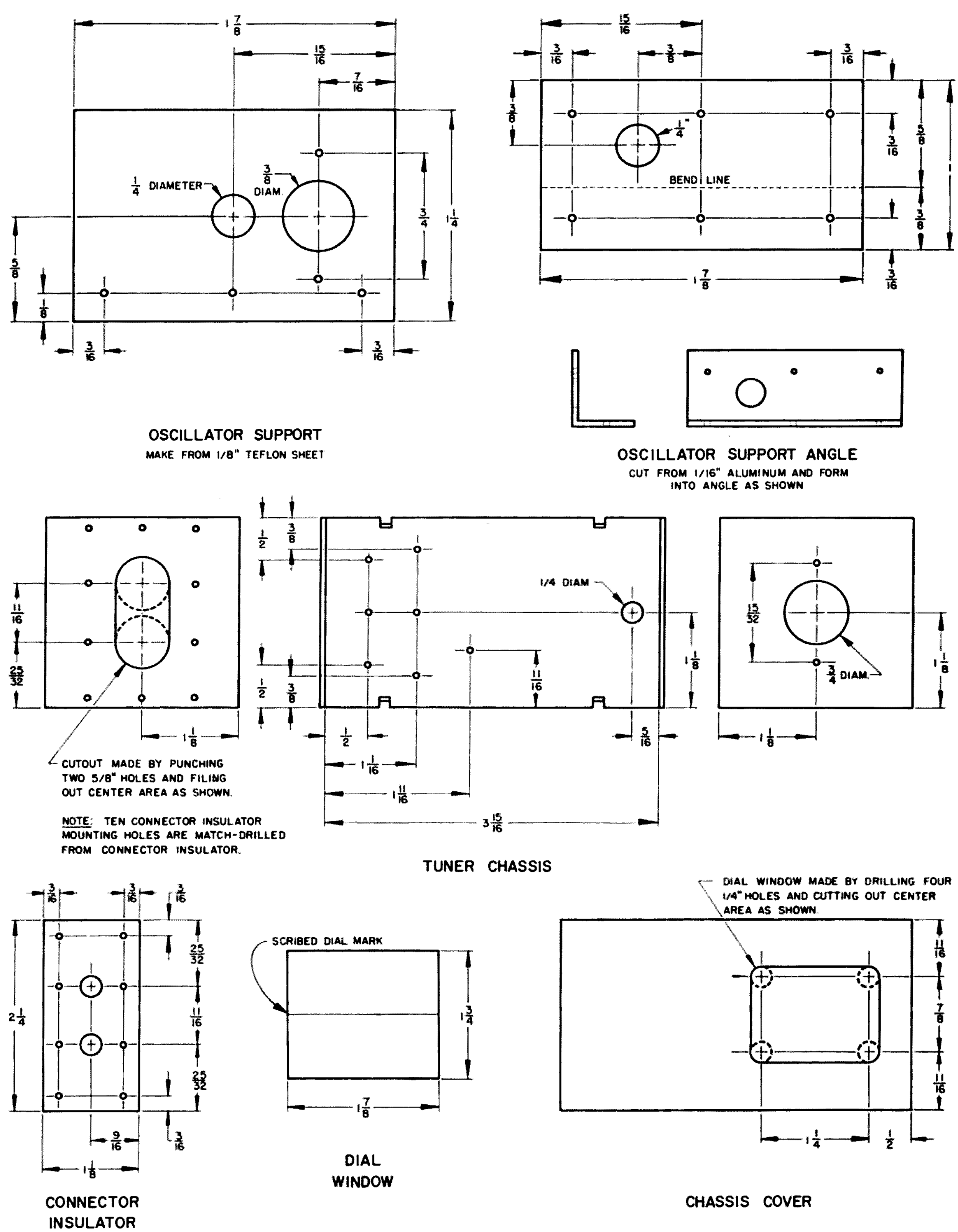


Fig. 4. Layout of the tuner chassis, chassis cover, dial, connector insulator, oscillator support and oscillator support angle.

ing it. The dial and coil socket cutouts are made by drilling or punching round holes and then cutting out the area between them as shown in the drawing. This is easily done with an Adel "nibbling" tool. All of the small screw holes are drilled with a standard ⅛ inch drill to pass 4-40 screws; 5⁄32 inch holes will be required if 6-32 screws are used.

The dial window is cut from a sheet of 1⁄16 inch clear plastic to the dimensions shown in

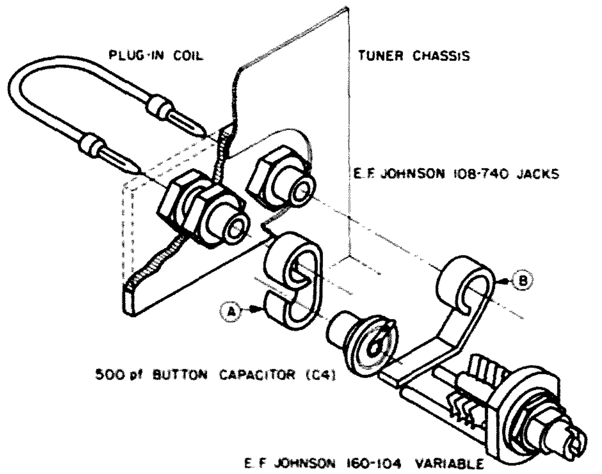


Fig. 5. Exploded view of the connections between the 6CW4 and the coil socket.

Fig. 4. A hairline is scribed in the center of this window; if a more distinct line is desired, this scribe mark may be filled in with black india ink. After the tuner enclosure is completed, this dial window is epoxied in place over the dial cutout.

The coil socket is made by installing two banana jacks (E. F. Johnson type 108-740) on 11/16 inch centers in the Teflon connector insulator illustrated in **Fig. 4** (if Teflon is not available, Polystyrene may be used). This "socket" is installed over the large oblong hole cut in the end of the chassis. The screw holes used for mounting the connector insulator are match-drilled to the holes in the insulator itself. In this way it is properly mated to the enclosure. Although nylon attaching screws were used in the original model, they are not necessary and regular metallic screws will not alter any of the oscillator's characteristics.

To reduce stray capacity to a minimum, the oscillator circuitry is mounted on an insulating sheet. Teflon was used for this purpose in the original unit, but epoxy board with the copper peeled off would be perfectly suitable. Sheet polystyrene is not too desirable in this location because of its susceptibility to heat. The envelope of the 6CW4 gets very hot and the ambient temperature within the confines of the small chassis is quite high.

The general layout of the Teflon oscillator support and associated support angle are also shown in **Fig. 4**. The angle is cut out from a piece of 1/16 inch aluminum sheet and bent in a vise to form the angle. When these two pieces are mated together, the metal angle will probably interfere with the lower nuvistor socket mounting screw. It must be drilled out using the hole in the oscillator support as a guide. This additional hole is not shown because its exact location will vary from unit to unit and depends upon the accuracy with which the parts are laid out.

The dial mechanism is not complicated, but it is hard to ascertain from the photographs exactly how it is put together. The exploded drawing of **Fig. 6** should help in this respect. The vernier mechanism is an Eddystone 10:1 planetary drive that provides both smooth action and repeatability in a small package. Although this unit is manufactured in England, it is available from many of the larger electronics parts houses in this country.[1]

Substitution of similar drives should be perfectly satisfactory as long as they don't extend more than one inch beyond the front panel of the tuner chasssis.

The vernier drive is connected to the variable capacitor through a ¼ inch polystyrene shaft 1-¼ inches long and the usual "¼ to ¼" shaft couplers. Polystyrene or some other insulator must be used here because the rotor of the capacitor must be isolated from ground. Because of the space limitations inside the enclosure, the coupler at the variable capacitor end of this shaft is only one-half of a standard coupler. A standard "¼ to ¼" coupler is sawed in two and one-half is epoxied to the end of the polystyrene shaft. Save the other half; it will be used for the dial drum hub.

The 8 pf variable capacitor was designed for screwdriver adjustment and its 3/16 inch shaft must be made compatible with the standard coupler. This is accomplished with a bushing made from sheet copper. A short piece of ¼ inch wide, 1/32 inch thick copper strap is formed around the capacitor shaft and takes up the slack between the shaft and the coupler.

The drum dial in the original unit was made from the metal top of a Johnson's Shoe Shine Kit (49¢ at the local grocer's), but any similar closed cylinder 1-15/16 inches in diameter and about 1-11/16 inches long should be suitable; other diameters will void the accuracy of the precalibrated dial. The "skirt" or bottom rim is cut off the metal can at the circumferential notch and a ¼ inch hole is drilled in the center of the top. The remaining half of the ¼ inch shaft coupler that was left over from the polystyrene shaft is then epoxied in place over the hole to provide a dial drum hub. Another hole is drilled in the side of the

[1]Arrow Electronics, 900 Rt. 110, Farmingdale, N.Y. $1.50.

can $^{11}/_{16}$ inches from the top; this provides access to the shaft coupler on the rear end of the vernier drive.

The precalibrated paper dial may now be cemented in place. It's a good idea to cement a piece of white paper the same size as the dial between the dial and the drum, otherwise the label on the can will show through the paper dial. Rubber cement is recommended at this point to prevent excessive wrinkling and distortion of the dial.

When all of the dial parts are completed, they are put together as shown in **Fig. 6**. It's a little crowded in the small box, but all of the parts *will* fit. However, in order to get all of the dial machinery into the box in the right order, a correct assembly sequence must be followed. First the polystyrene shaft and coupler are inserted into the dial drum from the rear. Next insert the Eddystone drive assembly through the hole in the front panel and mate it with the end of the polystyrene shaft. Place the bushing over the capacitor shaft, attach the polystyrene shaft and tighten the coupler; also tighten the coupler at the back end of the Eddystone drive thru the access hole provided in the dial drum. Install the vernier drive mounting screws. Now completely mesh the capacitor plates, center the low edge of the dial in the window and tighten up the dial drum hub. Disassembly must be accomplished in reverse order.

The tuning head is attached to the indicator/power unit through a four-conductor cable three feet long. This cable is attached to the box with a plastic cable clamp mounted in a hole provided immediately adjacent to the oscillator support angle and exits through a rubber grommeted hole at the front end of the enclosure. There is not enough room at the rubber grommet to use a cable clamp, so the cable is epoxied to the box at this point. Before installing the cable, however, check for sufficient clearance between it and the dial drum. It will probably be necessary to route the cable along the corner of the chassis to gain enough clearance.

Power indicator modulator

The power/indicator unit is housed in a standard 9 x 6 x 5 inch utility box (Bud type AU-1040 or equivalent). The layout of this circuitry is not at all critical, and just about anything that suits the builder may be used. The only particular caution that must be observed is with the transistorized 1 kc phase shift oscillator. This unit is built on a piece of perforated epoxy board (Vector 32AA18) 1-$^{3}/_{16}$ inches wide and 1-$^{11}/_{16}$ inches long. To preclude any 60 cycle pickup, this board is situated on the opposite side of the chassis from the power transformer.

In the author's case all the power/indicator components were mounted on a 4 x 5 x 1 inch aluminum chassis. This chassis was then mounted to the front panel of the utility box with the phone jack and power plug mounting nuts. Two large diameter holes (1-⅛ inch) are punched in the rear panel to provide access to

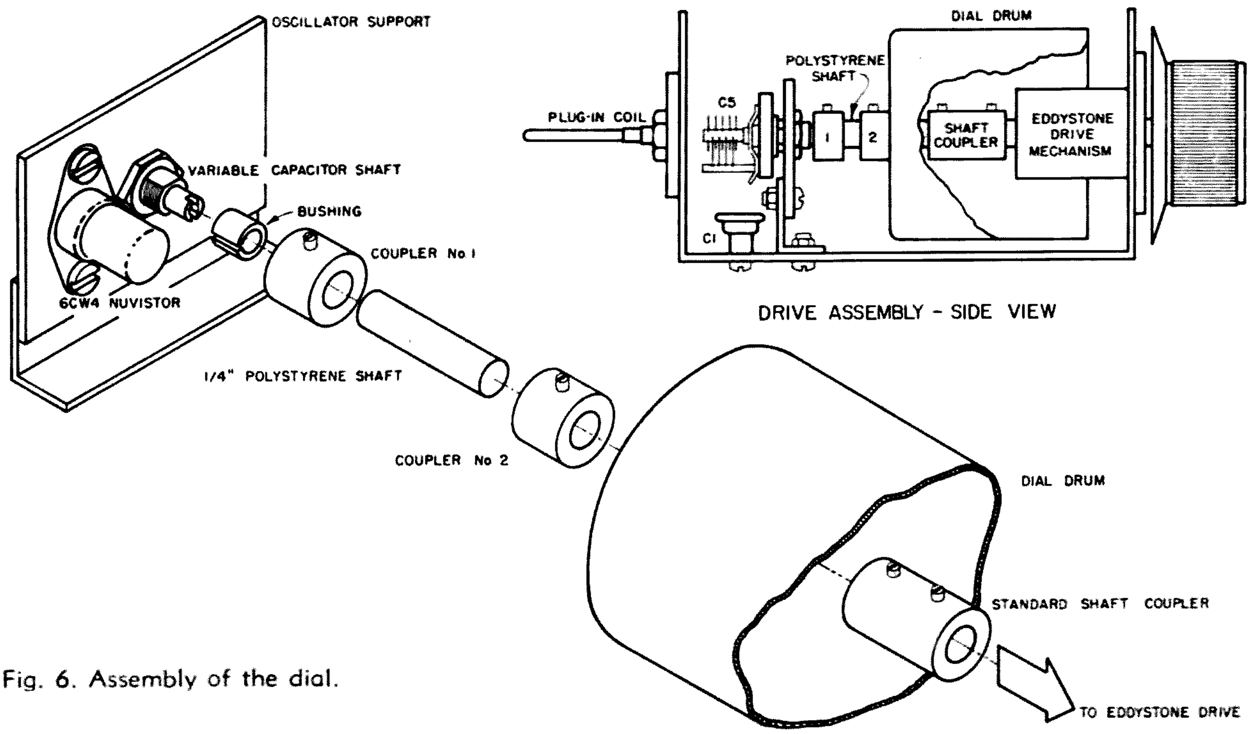


Fig. 6. Assembly of the dial.

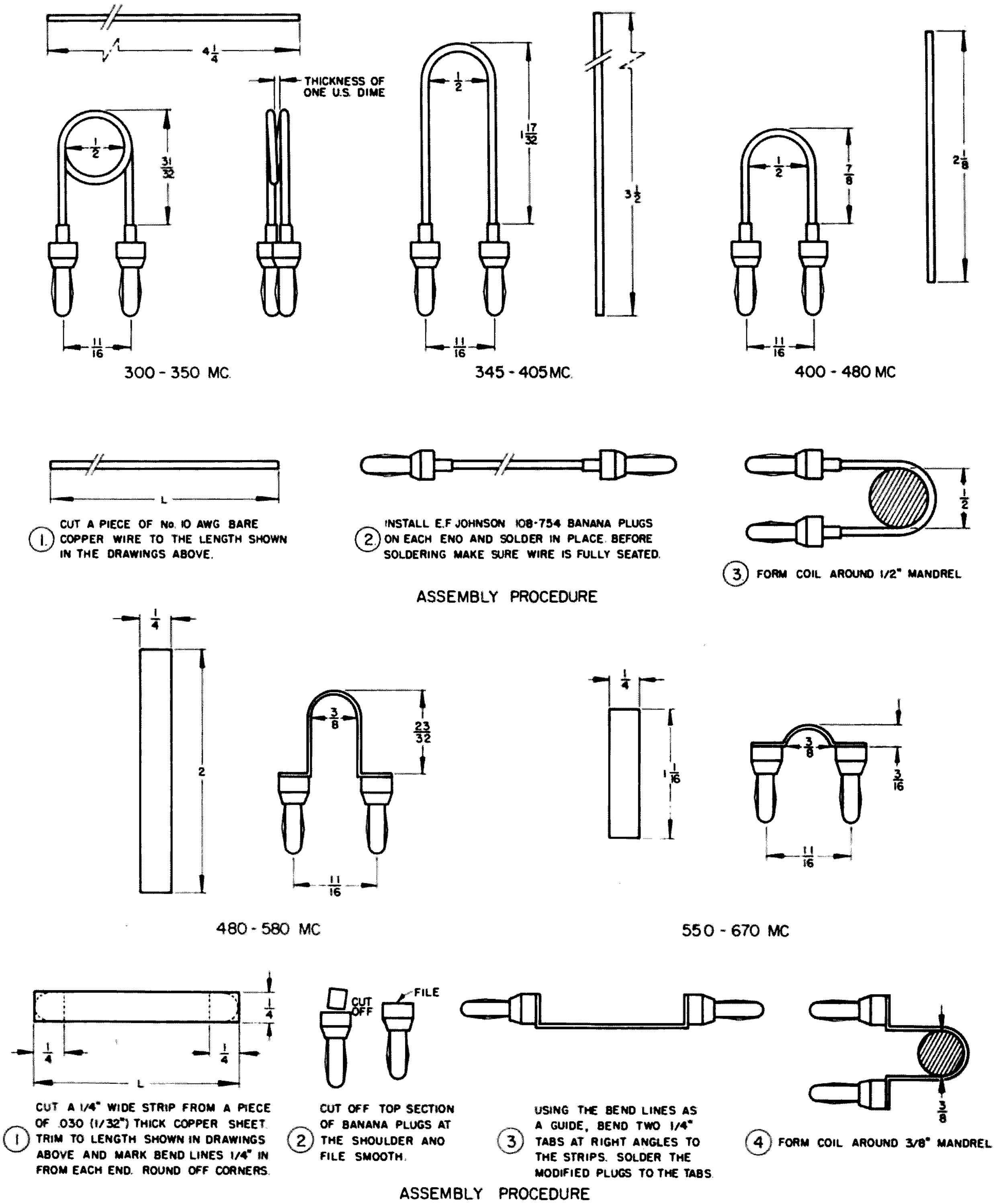


Fig. 7. The coils for the UHF grid dipper.

the fuse holder and to pass the AC power plug. A chassis handle (Bud H-9168) on the top and rubber feet on the bottom just about complete the unit. There is one other addition however; five pairs of 5/32 inch holes, drilled on 11/16 inch centers along the rear edge of the top of the box provide convenient storage for the five frequency determining coils. A coat of spray paint and some Datak "Letraset" dry transfer labels are the finishing touches.

Calibration and operation

Without access to existing 420 mc equipment with known frequency characteristics, exact calibration in this band is impossible. However, this grid-dipper may be checked on the other ranges with the aid of an all-band television receiver. If the circuit layout and

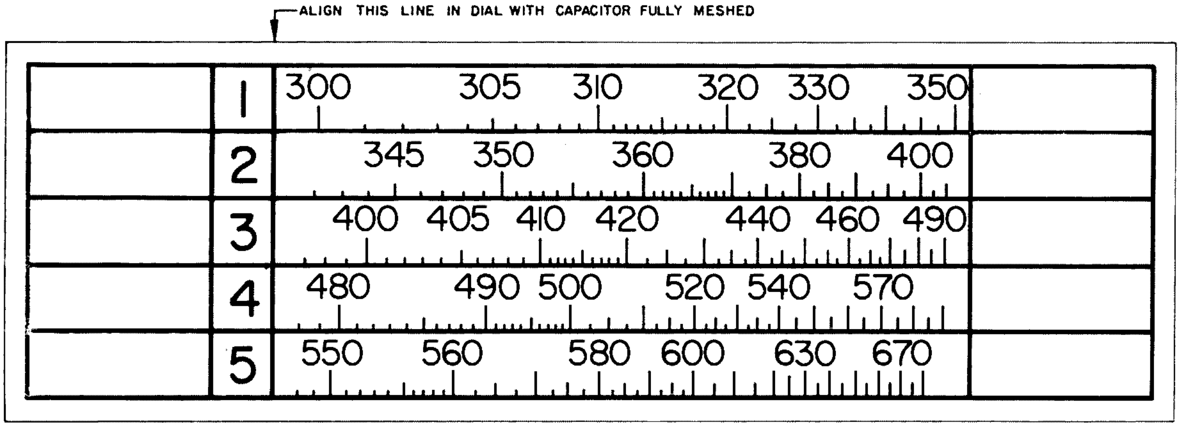


Fig. 8. Full size dial scale.

construction techniques described are closely followed, good correlation can be obtained and reasonable accuracy insured. The bands that are likely to be the furthest off are the lowest and the highest. In the lowest the coil spacing is quite critical and in the highest a slight change in length will move the frequency several megacycles. An accuracy of 2% at 600 mc is plus or minus 12 mc; close attention to the specified dimensions should provide accuracy better than this.

Operation of this grid-dipper is exactly the same as any lower frequency unit. It may be used in determining circuit resonance, detecting parasitic oscillations or as a signal generator. Because of its extended range, it has been found to be very useful in determining the series resonance point of rf chokes and ceamic bypass capacitors.

In the detect mode, this unit will indicate f voltages as low as 50,000 microvolts. More ensitive operation may be obtained if it is sed as an oscillating detector. In this case eadphones are used and an audio beat note ill be heard when the grid-dipper is tuned to he oscillator being checked. In the upper requency ranges, it is usually difficult to obtain an actual beat note, and only a "tick" will be discernible when you tune by the frequency of the unknown energy.

When the oscillator is tuned between 605 and 650 mc, there is sufficient second harmonic energy to provide a strong reference signal in the 1215 mc amateur band. This is particularly useful in the initial tune-up of converters for this band. Use of the internal 1000 cycle modulation aids in distinguishing the grid-dipper signal from other rf sources that are present throughout the spectrum. There are many other applications for which this instrument is suited, but entire books have been written on the subject and they won't be recounted here.[2]

Since this unit has been built, it has proven to be extremely useful in tuning up gear for 432. It has been borrowed a number of times and in every case a desire has been expressed for "one just like it". Hopefully this article and the pre-calibrated dial will fill that need.

. . . WA6BSO

[2]"How to Use Grid-Dip Oscillators," Rufus P. Turner, Copyright 1960, John F. Rider, Indianapolis, Indiana "Servicing With Dip Meters," John D. Lenk, Copyright 1965, Howard W. Sams, New York, N. Y.

Francisco Silva Jr. PY2CUB
Caixa Postal 30,123
Sao Paulo, Brasil

PY2USA

Call PY2, one of these evenings. Chances are you will get a prompt answer in English, from the city of São Paulo, in Brazil. You will be hitting quite a town—about 5,000,000 people in a melting pot that makes this the most interesting city in all Latin America. It is different, it is unusual, it is really cosmopolitan. To begin with, it is the most Americanized center below the Rio Grande, a sprawling city that is about thirty-five miles wide in an incessant growth that reminds one of Los Angeles, Chicago or Detroit. We *paulistas* are proud of our capital city for several reasons: It is a large industrial center right on the coffee belt of Brazil; agriculture and industry side by side in an amazing demonstration that the tropics do not produce only sleepy campesinos under huge sombreros. Bustling São Paulo will destroy any tourist's illusions as to the *mañana-mañana* image which may still exist in any visitor's mind. No other city in all Latin America has the many fortunate combinations that São Paulo offers in size, in climate, in modern facilities for comfortable living.

São Paulo is only forty-five miles from the beautiful bathing beaches of the seaport of Santos—and yet we are 2,100 feet above sea level! In fifteen minutes by car you climb all that and you are away from the warmth of a tropical seaside port. Still you have a comfortable temperature that seldom reaches freezing point in July or August, evenings are cool even in midsummer, hurricanes are things unknown to us—and all *paulistas* apologize to foreign visitors for our reasonable downpours in January or in March.

Take a walk down-town in this incredible city and look around. Nisei children show an amazing prettiness in their oriental features and distinctive European origin; Portuguese, German, Spanish, Italian blood of third-generation Brazilians seems to make a happy combination with the Japanese product! Towheads, redheads, slant-eyed *caboclos* of Indian descent are all Brazilians named Johnson, Whitaker, Pignatari, Giovanni or Takasaki. . . .

Read the trolley-car sign of destination: Brooklyn! Yes, it will take you to Brooklyn, a residential section of São Paulo, near another section called Indianapolis. On the way to Brooklyn you may drop off and walk down streets sounding so familiar to you Americans: Rua Nebraska, Rua Nova York, Rua California . . . . If your teenagers ask for it, just look around and you will find it: Snack-Bar, cokes, hamburgers, ice-cream sodas. . . . Sears-Roebuck is just five minutes away with counters displaying perfect copies made in Brazil of all those things to be found back home. The newsstands display New York papers just a few days old—and that certain TIMEly magazine which is distributed in Brazil on the issue's date! Brazilians are familiar with Little Joe of Bonanza—and with Flintstone adventures brought to us in TV tapes.

This is the town where PY2USA had to be created through imagination and originality. It is a radio club of the outstanding educational entity promoting closer relations with the U.S. since 1938—the well-known União Cultural Brasil-Estados Unidos, where 5100 pupils of all ages learn English and the American way of life by useful, practical and up-to-date methods. The organization occupies a modern building in an area almost the size of a city block. It is unusual in every detail because—well, it is in São Paulo!

PY2USA was officially opened on November 26th last. Its rig had been sponsored by the Glencoe Rotary Club, of Illinois, through the efforts of W9JKC, lawyer Byron C. Sharpe. He was present for the ceremony, when a Brazilian flag draping a plate on the wall was taken down by his own hands to reveal our humble tribute: PY2USA, Sala Byron C. Sharpe.

But this was just the initial step in our program of activities to foster better relations between Americans and Brazilians, the leading brotherhoods in this vast continent.

. . . PY2CUB

Art Lynch W4DKJ
2827 Valencia Way
Fort Myers, Fla.

W2USA/TV

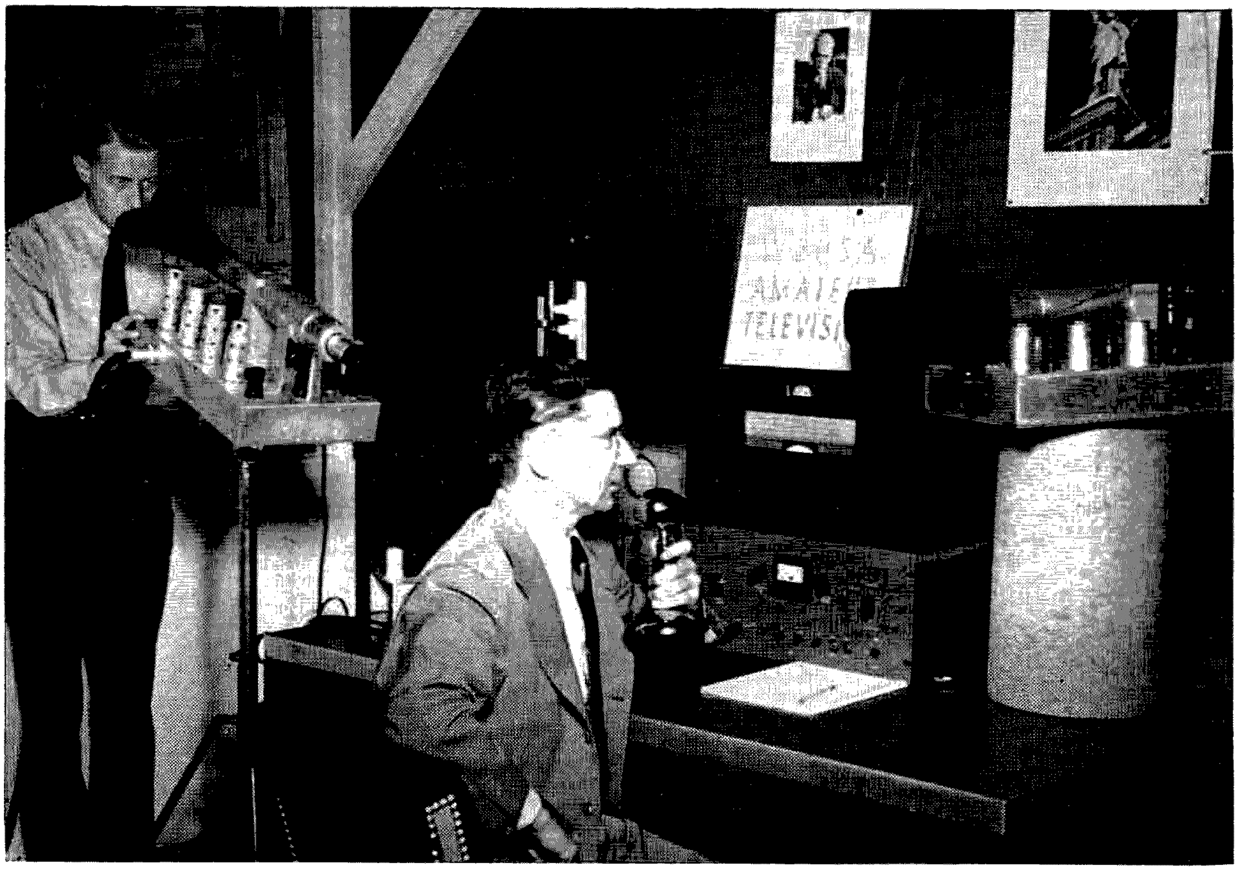
New York Worlds Fair 1940

Two-way television, with voice, was accomplished at the New York World's Fair in 1940, for the first time in history. It is very interesting to note that this remarkable achievement was the work of radio amateurs.

While the story of W2USA—the six-station amateur set-up at the World's Fair, 1939—is "Old Hat" to many old timers, there are now thousands who never heard of it, and a brief review is indicated.

One of the most active amateur radio groups in the metropolitan New York area was the Garden City Radio Club, of Garden City, L.I. One of the outstanding features of that club was the fact that it had no charter, no by-laws, no officers and no regular meeting times. By general choice, Stanley P. McMinn, W2WD, was "Honorary Secretary."

When several of the "gang" got their heads together and thought we should have a meet-



Before the opening gun was fired, for the public showing, a trial run was conducted. Here, Bill Meissner W2HYJ, host at W2USA/TV has the camera trained on Arthur H. Lynch W2DKJ, Managing Director of the W2USA Radio Club, who is shown chatting with Fred Cusick W2HID, operating similar equipment, on the roof of the New York Daily News Building, eight miles away. Some idea of the speed with which this circuit was tossed into operation, may be had from the location of the TV receiver, on top of a waste basket.

ing, Mac would be notified and it was his job to pass the word to all the members. Most of the meetings were sumptuous affairs, including complete bar service, the meeting, and then roast turkey and roast ham, with beer, wine or ale. As a rule, some prominent person, who happened to be in the New York area, would be the Guest of Honor. These meetings generally took place in the elaborate basement play rooms, in the home of former ARRL Hudson Division Director, Dr. Lawrence J. Dunn, then W2CLA and now, W2LP.

When Dr. John S. Young, the famous announcer, was asked by Grover Whalen, President of the N.Y. World's Fair, 1939, to become head of the Communications Department, it was Dr. Young's idea that amateur radio should have a prominent place in the Fair's activities. He communicated with ARRL and was told that Dr. Dunn could, no doubt, be of great assistance to him. He most certainly was. At his suggestion, the W2USA Radio Club, Inc., was organized. There were five Directors: L. M. Cockaday W2JCY; C. B. Cooper, Fiscal Director; Arthur H. Lynch W2DKJ, Managing Director; Dr. A. L. Walsh W2BW, and John S. Young, Liaison Director. There was a very impressive list of "Honorary Members", including: Dr. Lee de Forest, Pres. Lee de Forest Laboratories; Paul F. Godley, Pres. Radio Club of America; Raymond A. Heising, Pres., Institute of Radio Engineers; Lenox R. Lohr, Pres., National Broadcasting Company; Alfred J. McCosker, Pres., Station WOR; William S. McGonigal, Pres., Veteran Wireless Operators Assoc.; William S. Paley, Pres., Columbia Broadcasting Company, and Eugene C. Woodruff, President of American Radio Relay League. In anyone's book that would seem to be an impressive group!

Actually, the work done at the World's Fair began long before the fair opened. For instance, the famous "Round the World Round the Clock" Relay Message, to stations throughout the world, from Grover Whalen, was sent every hour, on the hour, for twenty-four hours, on New Year's Day, 1939, from the Fair Grounds, through W2DKJ2, to many relay stations, in the New York area and relayed by them, on most of the amateur bands, giving us world coverage. Within an unbelievably short time, just four hours, we received a reply, from a Llama Priest, in Tibet.

Art Lynch W4DKJ, former W2DKJ and W2USA (for the World's Fair), first went on the air as a ham when no licenses were needed. He served on a number of yachts, including the famous Wakiva and Wakiva II, was the first public relations director of RCA, editor of Radio Broadcast Magazine, a radio manufacturer, etc. He retired a few years ago from his own company in Florida.

Lola Lane, star of "Girls on the Road" photographed with an ordinary camera from the front of the picture tube, gives an idea of the definition which was possible. Stills were used for setting up, but live subjects seemed much clearer. It was generally agreed that definition was considerably better than this photo would indicate.
McMinn, W2WD photo.

Unfortunately, the impression was created in some quarters that all work from the Fair was to be carried on on 5 meters, which was the frequency (wave length, if you wish) to be used at W2USA, when we received our license. Incidentally, the license was not received until the day the Fair opened. All communications prior to that were handled by W2DKJ/2, located at the Fair Grounds. Actually, when we were completely set up, we had complete receiving, transmitting and antenna facilities operating on every amateur band then available—and all from a single room, in the Hall of Communications.

Some of the finest operators in the country helped us, both at our temporary "Shack" and through their home stations, handling "relays". Ultimately, when we did get our W2USA license, most of our problems were washed out. Because I was able to put in the necessary time to conduct affairs at W2USA, I was chosen Managing Director. Looking back on the job done at that time, I take a great deal of pride in the number of "Firsts" born there. And that brings us to the story of W2USA/TV.

While controlling the operation of W2USA, I was operating a radio manufacturing business, among other things, such as being the New York Representative of the National Company. As a member of the Radio Manu-

Lee Waller W2BRO, looks at the picture tube of the home-built receiver, as the first picture was received from W2DKJ/2, on the roof of the N.Y. Daily News Building, eight miles away, where Fred Cusick W2HID, a CBS engineer, worked for W2USA, on his spare time.

McMinn, W2WD photo.

facturers' Association, I was attending the annual "Trade Show", of RMA, in Chicago. Ed Braddock W3BAY, of the Amateur Division of the Radio Corporation of America and an old friend of mine, invited me to the RCA room, to witness the demonstration of the first showing of a special tube, which RCA was introducing for amateur TV use. The show was remarkable! From their room, in the old Stevens Hotel, they were able to produce rather good pictures of boats, out in the lake, a couple of miles away. Right then the idea of W2USA/TV was born. Months of hard work followed. As briefly as I can tell it, without leaving out any of those who helped to make it a success, here we go!

First, we secured the assistance of Lee Waller W2BRO, who had put on the show in Chicago. Using some of the techniques described in a series of articles by J. B. Sherman and himself, which had appeared in the May, June and July 1939 issues of QST, and with the co-operation of my good friend, Cliff Denton, then in charge of the Radio Department of the N.Y. Daily News, we set up a transmitter on the roof of the Daily News Building, in New York, and a receiving rig in our "Ham Shack" in the Communications Building, at the Fair Grounds. Fred Cusick, W2HID, an engineer with CBS, was selected to run that show. Boy, what a job he did! Fred, by the way, is still very active and has done much traveling with the Arthur Godfrey show.

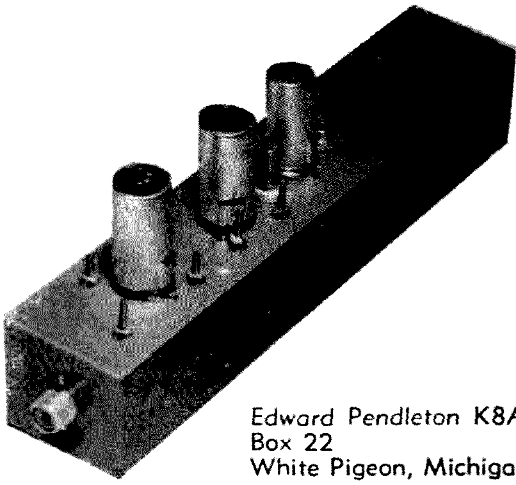
So, with this introduction, much longer than I thought it would be, I believe the photos, with their captions, can give you a fair idea of the job, done entirely by amateurs, more than a quarter of a century ago, of which they have every reason to be very proud.

. . . W4DKJ

Crowd around W2USA TV booth on the night the first two way circuit between the World's Fair and the Daily News Building, was opened.

A Bert Uthe W2JZO photo.

12 volts on Six Meters



Edward Pendleton K8ADG
Box 22
White Pigeon, Michigan

Here's a six meter crystal controlled converter designed especially for the radio amateur who has tasted the misfortune of using transistor VHF converters, and the poor compatibility of these units with high power VHF transmitters.

Several years ago the tube manufacturers went to a great deal of trouble to design a line of 12 volt tubes for radio receiving applications, yet few of these tubes have appeared in published ham radio circuits. I feel as though I'm resorting to antiquity to design a converter using them, however, the results proved excellent, and the compatibility with a 100 watt input transmitter proved well worth the effort.

After a thorough search of the tube manual I found the one tube that would merit operation in the VHF bands for RF and converter service. The 12EC8 is listed as a VHF triode-pentode which contains a medium mu triode and sharp cut off pentode. It is intended for use as a combined VHF oscillator and mixer where the heater, screen grid, and plate voltages are supplied directly from a 12 volt automotive battery.

The internal arrangement of the 12EC8 suggested a grounded grid first RF amplifier followed by a pentode second RF amplifier. This established the excellent noise figure to work with the pentode mixer and triode oscillator combination.

Four tuned circuits preceed the mixer in a stagger tuned broad band configuration with link coupling between the first and second RF and link coupling to the mixer input: affording the maximum rejection of adjacent signals and those on the intermediate freq.

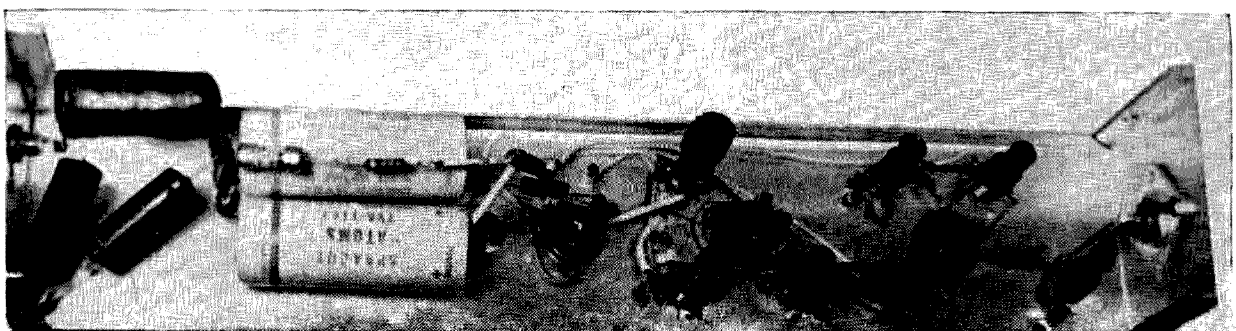
The overall performance of the triode-pentode combination RF amplifier already described is such that the mixer following it has substantially no effect on the noise figure of the system. I felt that the pentode mixer would be less susceptable to oscillation trouble and afford a better isolation between RF and IF and contribute to the ability of the converter to reject signals on other than the desired frequency range. The pentode has a higher conversion gain and due to inherent power sensitivity would require less oscillator injection voltage, allowing maximum sensitivity to S-1 signals.

One stage of *if* amplication follows the pentode mixer, before the output is passed on to the receiver.

The tubes in the converter are cathode type tubes and may be operated from AC. A built in ignition and AC ripple filter with a 1N60 diode provide everything necessary to operate either from 12 volts AC or DC.

Mechanical details

A 2½ x 2½ x 12-inch Minibox (Bud CU-2114) comfortably houses all components without crowding, although VHF circuit lead lengths were kept very short through careful parts layout. Holes are drilled in the box section having the 2½ x 2½-inch ends according to the photos. After drilling, larger parts are mounted on this chassis in the locations marked on this illustration. Tube socket pins are positioned in the direction indicated on each socket hole circle and fastened with a 4-40 x



¼ inch machine screws through holes drilled to match those on the socket. The lugs for the pins 1, 4 and 8 on the first and second RF amp socket are soldered to the center pin on the socket. The center pin is then grounded to a lug under the socket mounting screw near pin lug 4.

The lugs for the pins 3, 4 and 8 on the 12EC8 mixer tube socket are soldered to the center pin on the socket. The center pin is then grounded to a lug under the socket mounting screw near pin lug 4.

The lugs for pins 2, 3 and 7 on the *if* tube socket are soldered to the center pin on the socket. The center pin is then grounded to a lug under the socket mounting screw near pin lug 3.

Next, the heater and plate voltage leads are run to the tube sockets, RF coils, and the three insulated terminal posts, as pictured in the bottom view.

Resistors and by-pass capacitors which run between the tube sockets and ground lugs are then assembled. All coils and RF chokes, which previously have been wound according to the data in the parts data, are mounted between their associated components with shortest possible leads.

Link coupling between the first and second RF amplifiers is constructed of #20 enamelled wire with two turns at the cold end of each coil. The second RF to mixer grid coil link is #20 enamelled wire with one turn at the cold end of each coil.

Power connection is made through an RCA phono jack mounted in the end of the converter.

Adjustment procedure

All wiring should be re-checked after completing assembly, then power may be applied and measured at each tube socket before inserting the tubes. The input jack J1 is connected to the antenna. Output jack J2, is connected through a coaxial cable to the antenna terminals of a communications receiver covering the proper range. Install all tubes and a suitable crystal and a 0-3 ma meter is temporally connected in the plate voltage lead to L6. Output may be obtained from the oscillator over a wide range of L6, but a sharp dip in plate current should occur when oscillation at the crystal frequency takes place. Check the frequency of operation with the grid dip oscillator or a receiver tuned to the crystal frequency.

Conversion grid current at the mixer should be checked using a VTVM at the junction of R3 and R4. Negative .4V dc should be present with the crystal operating, falling to —.25V dc with the crystal removed. Approximately 10 to 12 microamps of grid current should be present for proper operation of the mixer.

Using the grid dip oscillator align the RF and mixer grid coils to the 6 meter band. For a final alignment some local long winded operator can provide a convenient signal source, and L1-L5 adjusted for maximum signal without oscillation.

. . . K8ADG

Parts Data

6 Meters:
L1, L2, L3, L4, L5-8T #20 CW ¼" form.
L6- 7 T #24 CW ¼" form.
L6A- 3T #24, cold end L6.

10 Meters:
L1, L3, L3, L4, L5, L6-16T #24 CW, ¼" form.
L2- 14T #24 CW ¼" form.
L6A- 4T #24 CW at cold end L6.

L7-Grayburne Loopstick.

L8-2.5 mh RF choke.

X1- Third overtone: 49.5 mc for 6 meter mobile; 43 mc for 7-11 mc **if**; 27.45 mc for 10 meters mobile; 26.3 mc for 11 meters mobile.

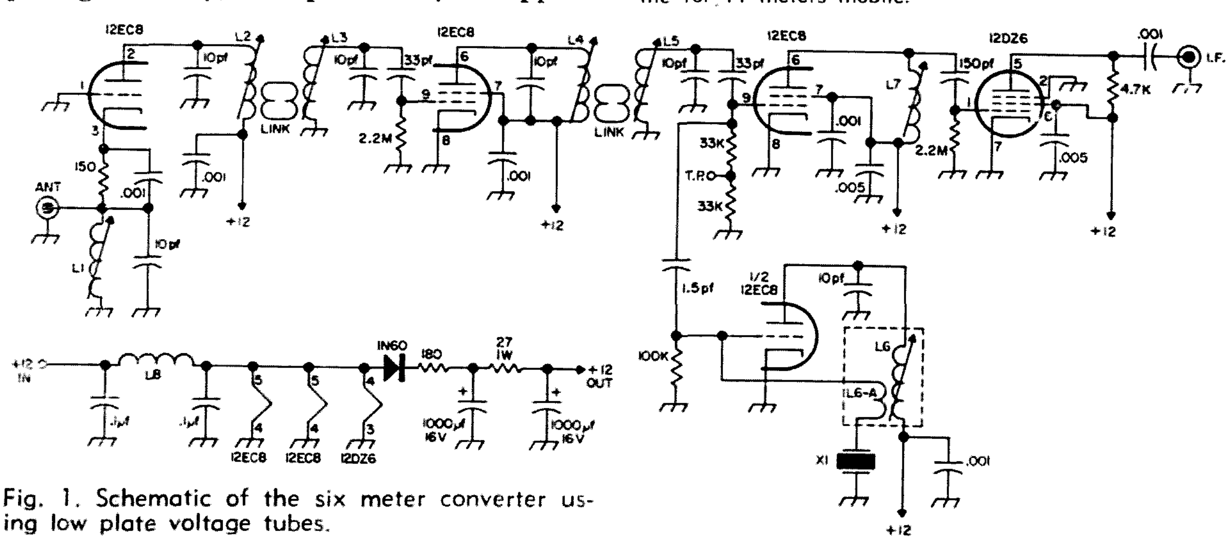


Fig. 1. Schematic of the six meter converter using low plate voltage tubes.

Ray Vath WB2FYB
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Teaneck, N.J. 07666

Getting on 432 the Easy Way

After reading about all the activity on the first UHF band allocated to amateurs, I decided it would be quite a bit of fun to try and get a signal on the air. After reading plenty of articles about the construction of all kinds of transmitters, I decided to experiment with one of my own; using a type of antenna coupling I had discovered while playing around on 220 mc. It may not look as though it would work, but this tripler works well and there are quite a few fellows who will testify to it. A few are WA2JVO, WB2COZ and W2NTY as they have all heard the signal to prove it.

Construction

This tripler is built on a 4x8 inch piece of aluminum which in turn is mounted on top of a 4x8 aluminum box. Construction should be exactly as the template indicates.

Starting at the grid end LI and L2 should be resonant at the frequency of 144 mc. It is a good idea to check it with a grid dip oscillator if you have one available.

L3A and L3B are four and a half inches long, bent down at the tube end one half inch so they are on the same plain as the part of the butterfly variable to which you will solder. L4 is a 1½ inch loop which is standard for this frequency except it is grounded at one end.

L5 is a four and a half inch piece of wire coupled to the plate tank closest to the ground end of L4 and adjusted for maximum output using a number 47 pilot bulb or whatever you may have.

B plus is applied 3 inches from the center of the 7 pf per section butterfly. On one of the few built so far, maximum output was acquired with the B plus 3¼ inches from the center of the condenser. So don't be afraid to play with this adjustment.

Tune-Up procedure

Apply 5 watts of drive to the input and turn C1 until the pilot light lights. Adjust L5 for maximum output. Connect an Antenna to the output. (I built the beam described by Hoisington in 73, December 1964. Note: If you want to get all elements on it, get a 14 foot boom; then call CQ and fight your way through all the QRM.)

Using the audio from the driver, you will be able to work the boys; but they will all tell you it is mushy. What I did was take an old record player audio amplifier and convert it to a modulator. This may be a good idea in case there are any official observers in your neighborhood.

By the way, the output of this gem is 4½ watts measured on a Bird watt meter.

. . . WB2FYB

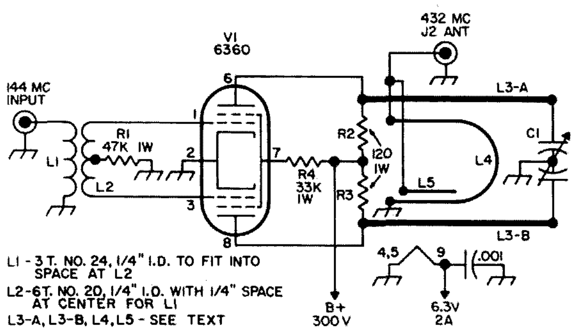
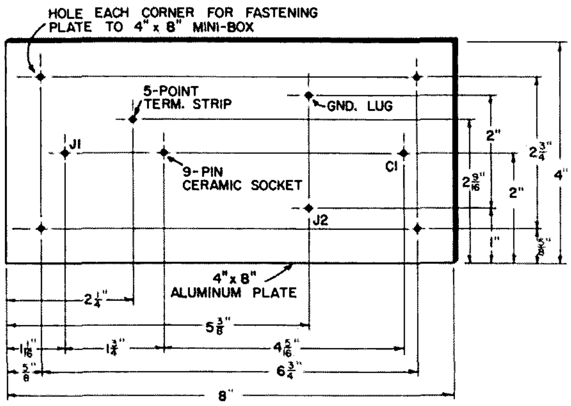


Fig. 1. Schematic of the tripler.



Layout of the tripler.

A year's run of four magazines in two handy volumes. The pile of leftover scraps is nearly nine inches high!

Dealing with the Information Explosion

James Ashe W2DXH
R.D. 1
Freeville, N.Y.

Researchers the world over are trying to do something about the information explosion. Too many unnecessary facts cover up the essential ones. But the researchers aren't the only ones facing this problem. There are anywhere from one to eight or more magazines in the amateur electronics market, depending on what your interests are. A few years' accumulation of these can use up a lot of space. And there is the further problem of finding, in a mass of advertising and often additional irrelevant material, a particular bit of needed information.

One solution is simply to throw out everything over ten years old. The rapid development of all engineering fields at present makes this a reasonable solution. However, there are two counts against it. The first is a growing tendency to print material of fundamental significance, which like mathematics, ages only very slowly. Much of Jim Kyle's work, for instance, can be expected to outlast by a good wide margin most of the construction material now being printed. Also, if only four magazines are retained, that will still be a standing file of about 480 copies from a ten-year period. Too much for browsing! A better solution is to save the useful and valuable material and discard the rest.

Gruesome details

Most modern magazines consist of several sections glued and stapled together. With some care, they may be dismantled into usable

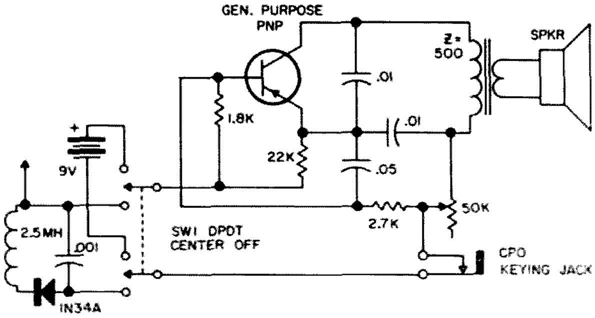
pieces without too much interference from the glue and cover. A certain amount of care is required because they are assembled for the ages, though you may doubt this from some of the content and the properties of the paper. The greatest difficulty arises where the glue has worked its way far in between two sections.

The first step is to find and remove the staples. A knife blade and pliers are appropriate; fingernails definitely are not. When the staples are out, the magazine is opened to page one and the process commences. One page at a time, decide if you have any future use for it. Check each page even if it's in a pure advertising or operating news section. Editors sometimes have funny ideas. Wanted material is removed by sharpening the crease at the back of the magazine and then tearing it out. If glue interferes, take the whole thing apart and cut off the usable page. Practice on other magazines of similar construction before getting into the good ones; it's quite important for future application not to spoil the inner edges of the pages. If you do, make a note of the month and page so the damage can be repaired later.

A year's supply of magazines will reduce to a remarkably small pile. Leaf through it and you will find that the general readability has been greatly improved. But all is not done yet! Paperback magazines are rather flexible and the pile of essentials will be much more so. One solution is stapling and storage in folders, each holding a year's material from a single magazine. But a better one is to have them all bound up in nice volumes. This is not very expensive, the local price being $4.50 for a volume up to three inches thick. Choice of colors, good library binding, and lettering included. Look around. If you have this done, a good arrangement is to place several blank pages for notes at the front and the back, and don't forget to bind in the yearly indexes! And you can economize by binding more than one magazine into a given volume. Same price.

The resulting volumes stand better, handle easier, take up less space, and are more readable than the original piles of magazines. Getting out all the trivial, dated and irrelevant material makes a phenomenal difference. There is just one magazine for which this does not work. Of course it is 73 (I dare not submit this to any other editor!) which has such a terrific ratio of content to volume that you must bind it whole. And it's become too thick for binding more than one year into a volume so there's no economy there. Oh well . . .

. . . W2DXH



CPO and CW Monitor

Here's a simple CPO/CWM monitor that I have been using at my station. It works very well. The antenna lead is a short length of insulated wire. Leave the switch in the center when not in use for code practice or CW monitoring, or it may annoy you!

. . . Gene Gillespie W2EAF

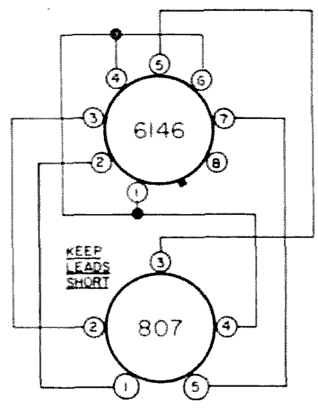
George Oberto K4GRY

807 to 6146

The new 6146B with its higher power and screen voltage rating is a natural to soup up an old 807 rig. Break the glass of an old 807, clean out the base and take an octal socket and wire it as in the diagram. Plug the adapter into the 807 socket, put a 6146B in the adapter, and with a slight returning of the grid and plate circuits you are ready to go without making any changes in your equipment.

I tried this out on Motorola 30 and 50D six meter FM equipment. The grid drive came up with the power output really climbing. A TBS-50 Harvey Wells, a GE rig, an Eldico and several homebuilt rigs were tried with similar success.

. . . K4GRY



An adapter for converting 807 rigs to 6146B's.

Hank Olson W6GXN
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Palo Alto, Calif.

A Self-Regulating DC to DC Converter

Apply 6 to 24 volts DC and get out 12!

Often in the use of electronic circuits, the available primary power is extremely variable in voltage, causing many undesirable effects in the circuit performance. One of the most aggravating effects of this type is that of the variation of frequency of oscillators as input voltage is varied. The aircraft or automobile radio receiver is perhaps the most common device plagued by this difficulty.

The standard method of handling the mobile problem is to use a transistor magnetically-coupled multivibrator type converter to provide isolation and voltage conversion, then use a series regulator.[1]

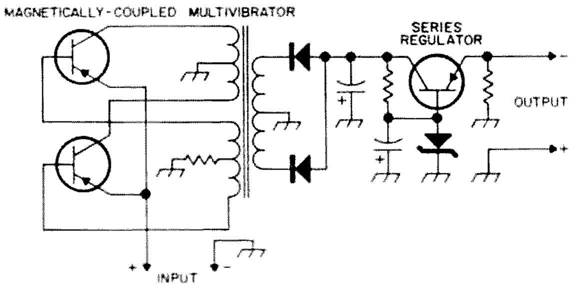


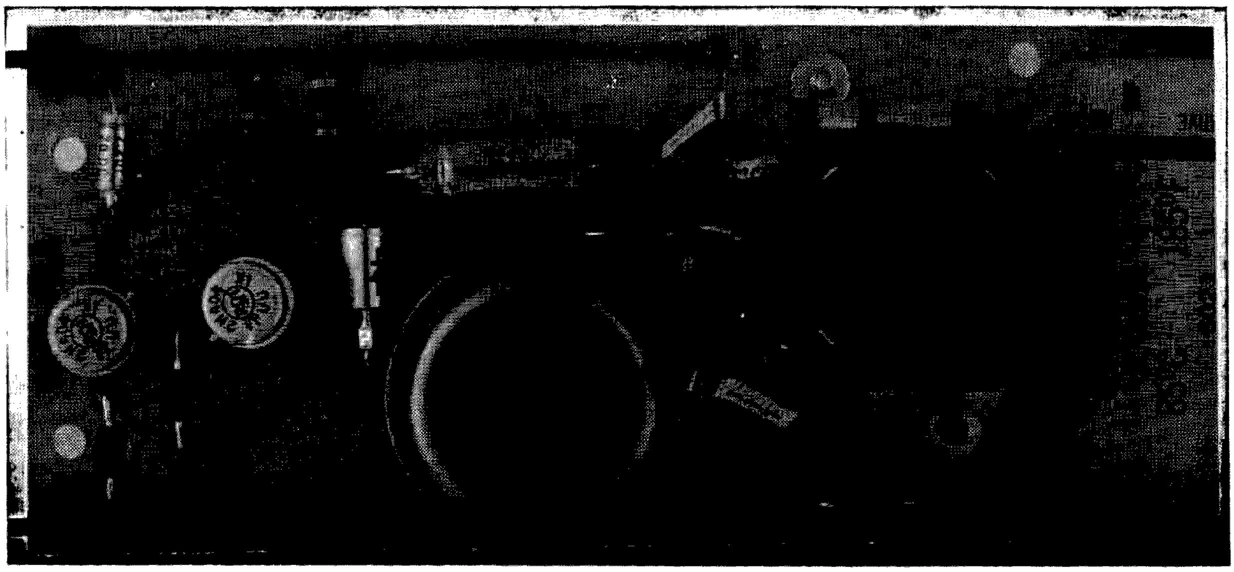
Fig. 1. DC to DC converter with a series regulator in the secondary DC circuit. This is not too efficient.

This means of regulating the output voltage of the converter is very fine, but rather inefficient because we must dissipate power in the collector-base junction of the series regulator. Such a system is simply shown in **Fig. 1.**

Improved efficiency could be obtained by using a switching-type regulator following the DC-DC converter. Such a regulator also uses a series transistor, but it is either saturated "on" or turned "off" completely. The output is then a pulse train, the average DC value of which (after filtering) is the output voltage. Either the pulse width or the frequency (of a constant width pulse) is made output-voltage-sensitive to effect regulation.[2] Such a system is shown in **Fig. 2.**

The device to be described here combines

Top view of the self-regulating DC to DC converter. Note that this is the opposite side from that shown in Fig. 5.



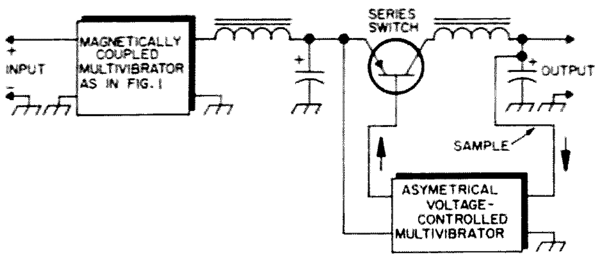


Fig. 2. DC converter with asymetrical voltage-controlled multivibrator regulation.

conversion and regulation in one simple circuit. It affords input-output isolation, high efficiency, and phenomenal input voltage tolerance. In fact, the unit will work on any input voltage from 6V to 24V with a constant output voltage of 12V. This would make it possible, for instance, to operate a transistor radio receiver on almost any type of vehicle having any battery voltage from 6V to 24V with either polarity grounded.[3]

The circuit is shown in **Fig. 3**, and it will be noted that it uses readily available and inexpensive parts. The total semiconductor cost is about ten dollars, and the transformer core will only cost about two dollars. The Siemens B65-701 in 2000N28 material with a 0.41 mm gap works nicely.

The regulation and efficiency are described in **Fig. 4.** It is rather a strange feeling to one to pick the device up as a "black box" and subject it to varying input voltage, with a 12V, 100 ma lamp on the output as a load. The bulb doesn't visibly change brilliance as the input is varied, and the input current *drops off* as we increase input voltage. This is all as it has to be, if efficiency is to be preserved, but to the "black box" viewer it at first appears to be black magic!

The circuit uses a rather large transistor for the power level in the series switch position. The 2N174 used is not even heat sink mounted, because it is not the 40 watt dissipation feature of this unit that is in use here. The 2N174

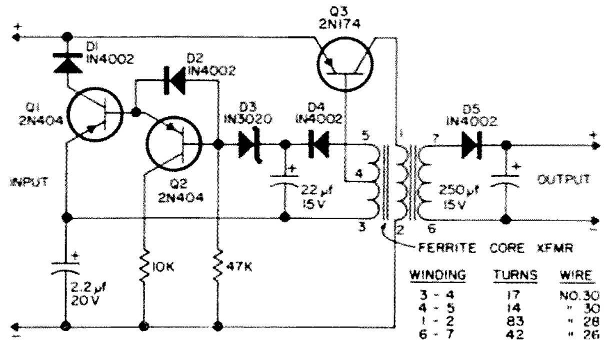


Fig. 3. Practical combined converter-regulator circuit. An input of 6 to 24 volts gives terminals 3, 1 and 6 are the beginnings of their respective windings. 12 volts output.

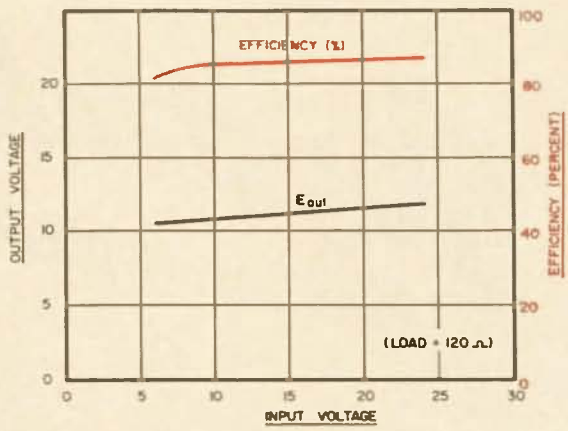


Fig. 4. Regulation and efficiency of the self-regulating DC to DC converter shown in Fig. 3.

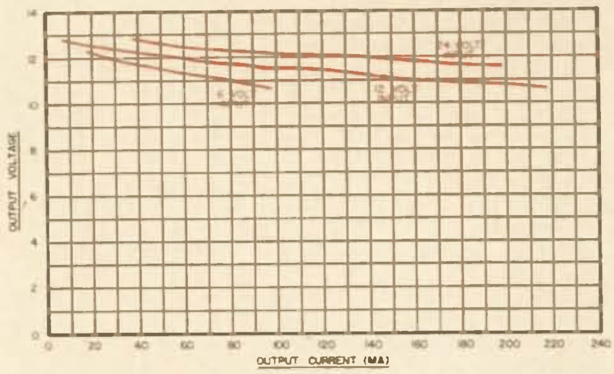


Fig. 5. Output current and voltage regulation with 6, 12 and 24 volts input.

was used simply as a low-priced compromise to give: (1) Low saturation voltage, (2) fairly high frequency cutoff, (3) high current capability, and (4) high breakdown voltage. (1) is understandable since the 2N174 is to act as a switch. (2) is to insure fast switching so that there is no large fraction of our duty cycle where there is appreciable voltage across the switch while current is being drawn through it. (3) is necessary because the maximum current drawn through the switch may be as great as five times the average input current. (4) because when the switch opens, there is a rather large inductive spike at the switch collector, and attempts to suppress this by means of capacitors increase the rise time of switching.

Surely there are other transistors which will work as well, and some perhaps better, but the 2N174 is the best this author has found. Since the features of low saturation voltage and high frequency cut-off are mutually incompatible, one has to pick his switch transistor to be a compromise. Either a high saturation or a low frequency cutoff will have the effects of lowering efficiency *and* raising the lower limit of regulated operation.

The converter is built on a circuit board which is etched to fit any of several series switch transistors; so one can try others if one wants to do so. The board fits into an L.M.B. 108 box chassis, for packaging.

This particular unit is used to power an FM receiver made up of Gorler transistorized sections. The unit is used part time in a Volkswagon on 6V with a positive grounded system and used part time in a Chevy II on 12v with a negative grounded system. The versatility of the converter makes this type of operation completely successful.

. . . W6GXN

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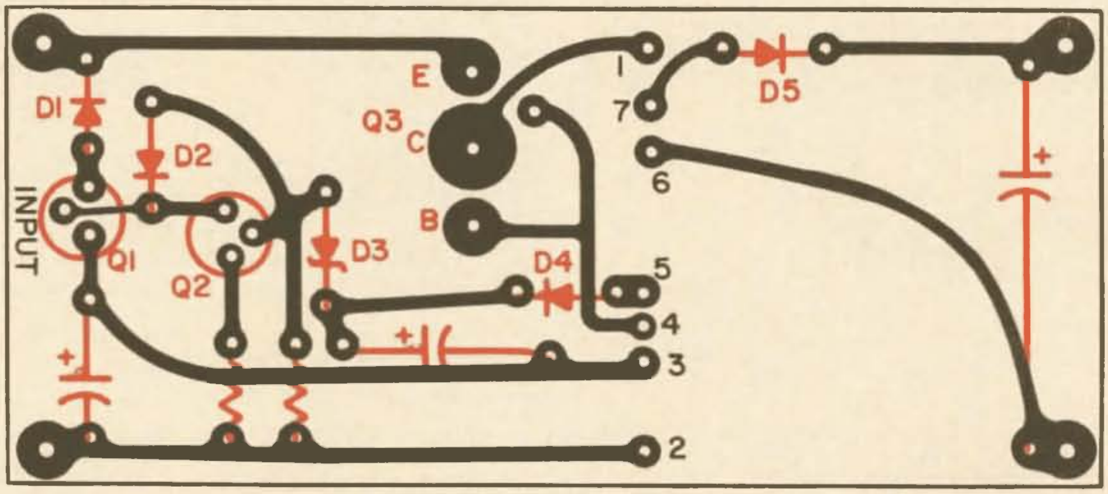

Fig. 6. Full-size printed circuit layout. This view is from the copper side, showing where the components lie on the opposite side.

Jim Kortge K8IQY
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A Simple End of Line Indicator

This is an article to present a simple counter that works well as an end of the line indicator for the Model 14 typing reperforator. It will work equally well on any other type of reperforator, providing it has a punch bail used to operate a cam which in turn is used to close two contacts of a leaf switch each time the bail moves back. The cam-switch arrangement can be added to any reperforator by using one's imagination.

As can be seen from the schematic, the circuit is very simple. The power transformer was taken from an old television booster but anything that will supply the necessary 180 volts for the high voltage and 6 volts for the filament of the 6C4 will work fine. The rectifier is a 1N2071 silicon rectifier in a simple half wave circuit. The filter capacitor can be anything from 40 μf on up. The voltage regulator was included after the authors found that, without it, the counter was not accurate, due to changes in the line voltage. After the VR150 was added, the counter was accurate to plus or minus one pulse. The dc voltage is keyed by the cam-switch arrangement mentioned earlier. The rest of the circuit is composed of an integrator network and a dc amplifier. Each time the switch is closed by the cam, it sends a pulse of voltage through the variable resistor into the capacitor. The capacitor stores the pulses of voltage until the level is high enough to fire the NE-2 neon bulb. When the NE-2 fires, it drives the 6C4 grid positive making the tube draw a larger amount of current. This increase in plate current pulls in the plate relay which is in the plate circuit of the 6C4. When the relay pulls in, one set of contacts rings a bell indicating a full line has been punched, while the other set of contacts shorts out the capacitor, discharging its stored voltage, and the counter starts counting at zero again. The 10 μf capacitor across the winding of the relay gives a "hold in" time of about one second. This makes the bell ring for a short period instead of just striking once. It also provides a longer time to discharge the stored voltage in the capacitor. The purpose of the reset switch is to set the counter to zero at any time. Because we are typing blind when we use the 14, we sometimes forget where we are in our train of thought. When we start a transmission to any station we send his call, de K8JAC or K8IQY in Midland, Michigan returning, then reset the counter and proceed.

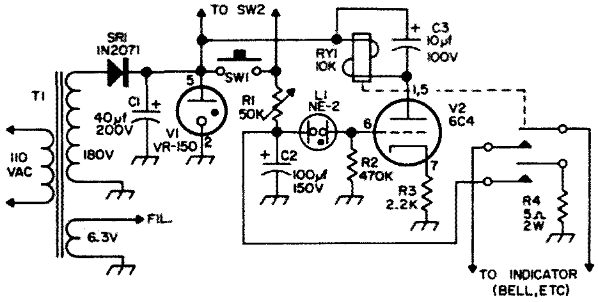

Fig. 1. A simple end of line indicator.

We hope this article will be helpful to those amateurs who have reperforating equipment in the shack but have not gotten it on the air because they lacked the necessary end of the line indicator. Although the one we constructed is not accurate to the pulse, it is accurate enough so we never over print another station's machine because we have punched too long of a line. At the present time we are using a 65 character line. As most machines will print a 72 character line before they over print, this gives a wide margin of safety with the plus or minus pulse accuracy of the counter. The number of characters to a line can be set to any number by the individual operator. This adjustment is made with the potentiometer in the integrator circuit. On our model we can vary the number of characters to a line from 40 to 80 with the 50 K potentiometer that we used.

. . . K8JAC, K8IQY

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How Much Capacitance for the SSB Rig?

Or: Beat the high cost of microfarads

Once upon a time I decided to build a big linear. (Didn't we all.) I had the big bottles, a power transformer, choke, sockets, chassis, variable capacitors, and even a circuit diagram for the final. No sweat so far. Let's draw the diagram for the power supply, haul out the surplus catalogs for the miscellaneous components and away we go. ## !! Look at the prices on those capacitors! They cost many dollars per microfarad. The higher the working voltage, the higher the price. Maybe we don't need 80μf at 3 kv after all. Let's see what the Handbook says. "The output capacitor should present a low reactance at the lowest frequency of interest." Thanks a lot, Buddy. What's low?

After going through the above line of reasoning, I got to wondering, "How much is enough? The following half-baked hypotheses are presented in the hopes that we'll all save money. The approximations are my own, and the entire process is presented so that it can be fudged at any point where you think I've guessed too conservatively, or conversely, come too close to the ragged edge.

A summary of the energy transfers involved would present a clearer picture of the quantities involved than a consideration of the impedance of an amplifier whose plate current varies. That output capacitor can be regarded as a storage device. There are times when the terminal voltage of the capacitor is well above the voltage supplied to it, since the input is pulsating. If there's an inductor (choke) ahead of the capacitor the voltage developed across the inductance when current is drawn through it opposes the change in current. This drops the supply voltage to the capacitor again. Consequently, in either case, the capacitor is standing alone for a while as a supplier of power for the final. The capacitor has $CV^2/2$ Joules stored in it, where C is in farads and V in volts. (We'll take care of the units later.)

Now comes the first of the assumptions. If the power supply is a half wave job, there is 1/60 second, or something less, between the intervals when the power supply is putting power into the capacitor. As a sort of worst possible case, assume that this capacitor must supply the entire amplifier input power for the full 1/60 second. This power is VI, where V is the power supply voltage and I is the peak dc current that the final stage draws.

While the capacitor is supplying the energy the voltage across the capacitor is going to fall off some. The amount of decrease is

$$\frac{C(V_1^2 - V_2^2)}{2} = VI \times \frac{1}{60}$$

In the above equation I assumed that the drop in voltage is small enough that V_1, the maximum voltage across the capacitor doesn't change much and is approximately V. (Purists may substitute $\frac{V_1 + V_2}{2}$ for V and go on from there.)

The question is: how much can this voltage be allowed to fall off without giving some distortion or noticeable decrease in power at the antenna? The second assumption is that we can stand a 1 db drop in power. If the current doesn't change much,

$$20 \log \frac{V_1}{V_2} = 1 \text{ db, or } \log \frac{V_1}{V_2} = 0.05$$

The number whose log is 0.05 is 1.122, so:

$$V_1 = 1.122\,V_2, \text{ or } V_1^2 = 1.26\,V_2^2 \text{ so}$$
$$V_1^2 - V_2^2 = .32\,V_1^2$$

going back to the expression with the capacitance in it;

$$\frac{C \times .32 \times V_1^2}{2} = \frac{V.I}{60} \text{ or, finally, } C = \frac{I}{V \times 9.6}$$

To use this as a formula giving C in microfarads, use I, the peak current to the final, in milliamperes and V, the final plate voltage, in kilovolts.

Note an economically fascinating fact about this equation. For a given input power, as the plate voltage goes up, current goes down,

and, effectively, the amount of capacitance goes down as the square of the voltage. Since, as you remember, the price of capacitors seems to go up about the same way, the money comes out about even. But using this equation we're not misled into thinking that because a low voltage SSB rig uses 80μf filters we have to use 80μf at 3000 volts.

For example: a 1 KW PEP rig with 500 volts on the plates would draw 2 amperes on peaks and require from the formula an output capacitance of 410μf for a 1 db drop, running full bore. A 1 KW PEP rig with a 2 KV plate supply and 500 ma peaks would require about 26μf for the same 1 db drop:

$$C = \frac{500}{2 \times 9.6} = 26$$

Notes on the assumptions: The assumption that the capacitor supplies full power to the final is only going to apply for an almost square envelope output, a case you would only get with either CW or clipping of the sort used by the Clegg VHF gear. For unclipped SSB, a sine wave assumption might be better, in which case only half as much capacitance would be necessary. For full wave rectification only half of that will be required.

The assumption of an allowable 1 db drop in power was taken because 1 db is the minimum detectable change to the ear. One KW falls off to 800 watts at 1 db down, though, so 1 db might be a bit much.

Don't blame me if somebody's commercial gear uses less capacitance than the equation calls for—they may have settled for a drop of more than that 1 db that I assumed. Just say "aaah" into the mike and see if the output power meter drops as the syllable goes on.

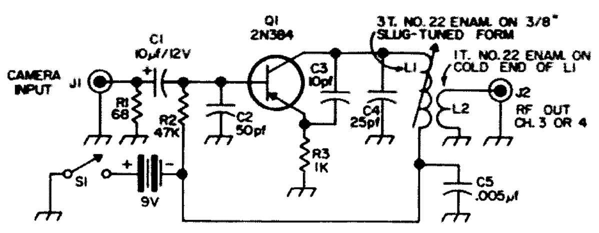
. . . W4VRV

A Simple Oscillator for Monitoring ATV

Ralph Taggart WA2EMC

Monitoring the output of an ATV camera, whether it's a flying spot scanner or a vidicon, can present a few problems. If the TV set you would like to use as a monitor is a fairly new one, there is often a little reluctance about cutting into it to make the necessary modifications. A second problem arises if you want to give a closed circuit demonstration at a hamfest, club meeting, or at someone else's shack. The usual procedure is to pack both the camera and TV set into the car and take off, but in my case anyway, this produces an inconvenience factor which is directly proportional to the size of the set and inversely proportional to the size of the car. This unit, which will fit into a small Minibox, will solve both these problems. Basically, it is a low powered TV transmitter which, when parked next to any TV set, will allow you to view the output of your camera, with no connecting wires and no set modifications.

Q_1 serves as an oscillator, tuned to an unused TV channel between 2 and 6. The oscillator is base modulated by the camera, with a 68 ohm resistor serving as a termination for the coaxial cable carrying the camera output. C_4 and L_1 are the principle frequency determining elements, and with the values shown, it will hit channel 3 or 4, depending on the setting of L_1. If output on another channel is desired, one or two additional turns on L_1 should get the oscillator on channel 2, while reducing C_4 to about 10 pf and juggling the number of turns on L_1 will give output on channels 5 and 6.



The ATV monitor oscillator. The author recommends replacing the 2N384 with a more modern transistor such as the 2N1746 if there is trouble maintaining oscillation when the input is loaded.

The output jack can be a coax connector, a phono jack, or even a binding post. Only about one or two inches of wire connected to the output jack will be sufficient for a good picture when the unit is placed next to the TV set. Keep in mind that a TV channel is not a ham band, and more output than you need won't improve the picture, but in many cases, it might get you in hot water!

My unit was constructed on a 2x3" piece of Vector board and packaged in a 2¼ x 2¼ x 4" Minibox. Mounting the input connector at one end, with the output at the other makes a compact arrangement. A SPST switch and a 9 v transistor battery complete the unit. The battery may be taped to the bottom cover of the Minibox, and if you don't forget to turn it off for a week or two running, you should get just about the normal shelf life. The modulation level can be controlled with the camera gain control.

This little gadget literally uses only a handful of parts, but you'll wonder what you did without it.

. . . WA2EMC

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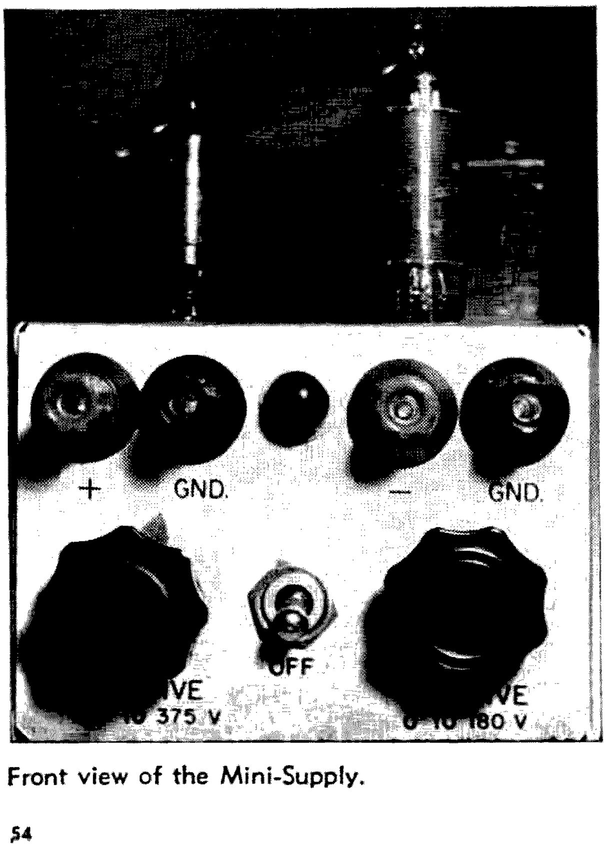
The Mini Supply

How many times have you wished that you had one more source of high voltage? Invariably when breadboarding circuits, one of the problems that arises is the need for an additional source of regulated voltage. This is particularly true in VHF and microwave work when setting up *if* strips, mixers and other peripheral equipment. Furthermore, this type of work usually requires a certain amount of portability. Unfortunately, most bench type regulated supplies are rather bulky affairs which don't lend themselves too well to moving around. In addition to being simple, inexpensive and lightweight, the truly versatile supply should provide both variable positive and negative voltages. With these requirements in mind, the "mini-supply" was constructed.



Front view of the Mini-Supply.

This unit is compact, inexpensive, and provides an adjustable positive voltage from 125 to 375 volts and an adjustable negative supply from zero to —180 volts.

Until recently, the realization of a really lightweight, high-voltage regulated power supply was next to impossible; with the advent of inexpensive semiconductor diodes this is no longer true. There is no doubt whatsoever that transistors are here to stay; but for many high voltage applications vacuum tubes are still a better choice at the present state of the art. However, the use of silicon rectifiers and regulator diodes cuts size, weight, and cost. In fact, with a little shopping around, semiconductors may be obtained at a lower cost than equivalent vacuum tubes. For example, the total cost of the diodes in this unit was $3.57. The vacuum tube equivalents (assuming a 5U4G full-wave rectifier, a 6X4 half-wave rectifier and three OB2's) would run about $3.75, even on the surplus market. The hybrid design of **Fig. 1** evolved by using the best characteristics of both silicon diodes and vacuum tubes to the most advantage.

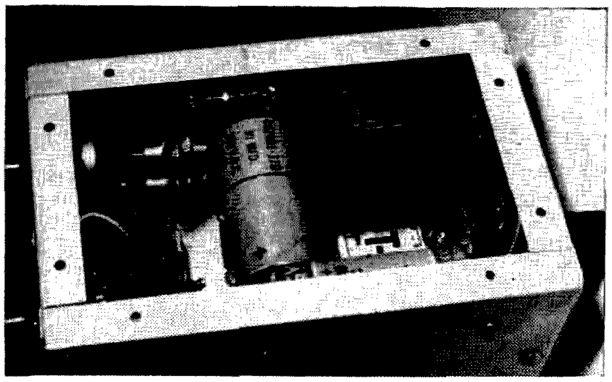
In essence, the positive voltage section of this power supply consists of a simple series regulator in series with the B+ line. A small portion of the output voltage is picked off at the 25K pot and fed to the grid of the 6AU6 voltage amplifier. The cathode of this tube is maintained at 90 volts above ground by the 90 volt, 450 milliwatt zener diode in the cathode lead. The voltage fed into the grid is compared to this 90 volt reference signal and the plate voltage varies accordingly. This voltage controls the grid of the 6AQ5A series regulator and determines the voltage drop across it. In other words, the 6AQ5A series regulator acts like a voltage-controlled resistor in series with the high-voltage line.

To show how the regulation process works, consider the case where the load increases and tends to lower the regulated output voltage.

As the output voltage goes down, so does the voltage on the grid of the 6AU6. As the grid voltage decreases, the plate current flow decreases and the plate voltage goes up because there is a smaller voltage drop across the 220K ohm plate load resistor. Of course, this increasing plate voltage is reflected on the grid of the 6AQ5A regulator tube; the cathode current increases and the cathode voltage goes up. Actually, all this happens instantaneously and any time the output voltage tends to increase or decrease, the voltage amplifier and series regulator immediately compensate just enough so that the output stays at the same level.

When you want to change the output voltage, rotation of the potentiometer changes the voltage at the grid of the voltage amplifier. This voltage change sets the electronics in motion and the circuit immediately tries to compensate; this results in the desired change at the output.

Any compact high-voltage power transformer with about 350 volts each side of center tap at about 100 mils is suitable for this supply. The exact voltage is not too important because there are inherent differences between regulator diodes and slight component adjustments will be required anyway. However, don't let this frighten you; the only component that will change is the 6800 ohm resistor between the 25K pot and ground and the proper value is easily determined. Simply attach the lower end of the 25K pot to ground and measure the voltage at the cathode of the 6AU6 as the potentiometer is varied from one



Bottom view of the Mini-Supply. Note the mounting of the zener diodes (right center) and the way the components are stacked up around the edge of the chassis.

end to the other. You will note that the cathode voltage remains constant at about 90 volts over a rather wide range of potentiometer resistance, but abruptly falls off as the arm of the pot passes a certain point approaching ground. Below this "break-off" point, the cathode current of the 6AU6 is insufficient to maintain proper zener regulation; therefore, a resistor must be placed in series with the pot to limit the resistance between the 6AU6 grid and ground to the required level.

To determine the required series resistance, set the pot slightly above this breakoff point, turn off the power and measure the resistance between the arm of the pot and ground. Assuming that the measured resistance is 5600 ohms, the simplest approach at this point would be to remove the 25K pot from the

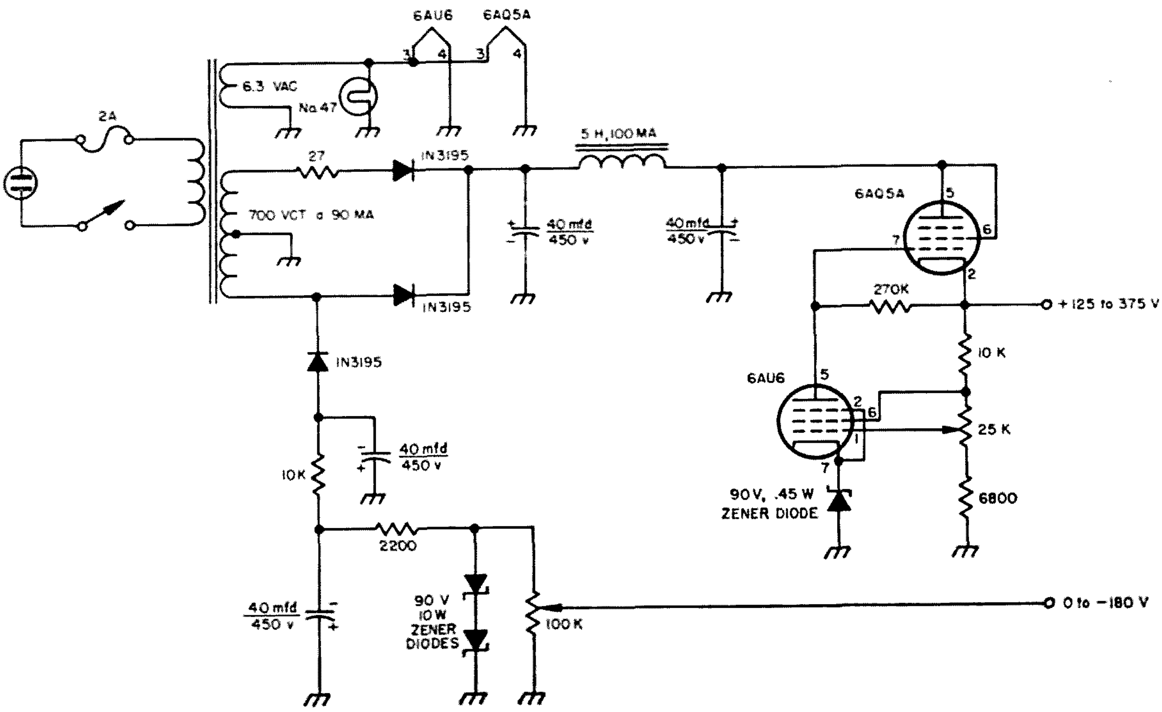


Fig. 1. The Mini-Supply.

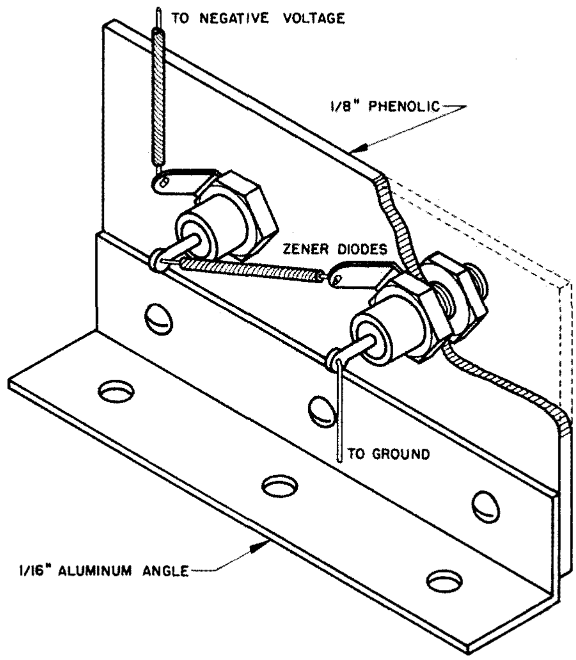


Fig. 2. Mounting the ten watt zener diodes.

circuit and replace it with a 20K pot in series with a 5600 ohm resistor. This combination would pretty nearly meet the requirements, but being economical at heart, why not use the 25K pot in series with a value of resistance which provides the same voltage ratio? Using the measured value of resistance (5600 ohms), the correct value of series resistance may be calculated by the following procedure:

1. Calculate the ratio (designated K) of the measured resistance (R_m) to the total resistance in the voltage divider (R_T). In this case the total resistance consists of the 10K resistor in series with the 25K pot or, $R_T = 35000$ ohms. Therefore

$$K = \frac{\text{Measured Resistance}}{\text{Total Resistance}}$$

$$= \frac{R_m}{R_T} = \frac{5600}{35000} = 0.16$$

2. Calculate the value of the added series resistance (R_s) from the following relation:

$$R_s = \frac{R_m}{1 - K}$$

In this example where $R_m = 5600$ ohms and $K = 0.16$,

$$R_s = \frac{5600}{1 - 0.16} = \frac{5600}{0.84} = 6667 \text{ ohms}$$

3. Select the next largest standard value of resistance for the series resistor (6800 ohms in this case).

With a properly adjusted output resistance combination, the positive voltage is continuously variable from about 125 volts to 375 volts. The current capacity of the positive supply is limited by the current rating of the transformer at the higher voltages and by the maximum permissable plate dissipation of the 6AQ5A at the lower voltages. For a unit with 100 milliamp power transformer, operation should be maintained within the "safe operating range" diagrammed in **Fig. 3.** Regulation is not as good above 325 volts as it is on lower voltages, but it is still stiff enough for the majority of breadboard circuitry and bias applications.

Thus far very little has been said about the variable negative voltage. This circuit is a straightforward shunt regulator using zener diodes in place of the familiar gas regulator tube. With the diodes shown in the schematic, this voltage is available from zero to about −180 volts. The current capacity of the negative supply is determined by the power rating of the regulatory diodes; for 10 watt devices, 30 milliamperes is available on a continuous basis. With the addition of a suitable heat sink, this could be just about tripled, but a much larger chassis would be required.

Most of the commercially available stud-mounted regulator diodes are designed for regulating positive voltages and as such, the chassis mounting stud is located at the cath-

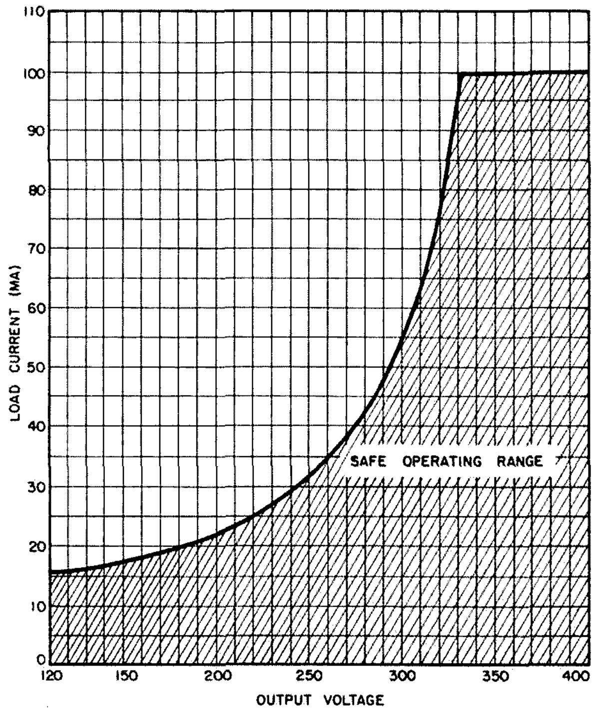


Fig. 3. The Mini-Supply should be operated within the safe operating range above.

ode stud must be isolated from ground. A simple way of accomplishing this is illustrated in **Fig. 2.** Although this mechanical arrangement seriously limits the total dissipation of the diodes because of the poor heat conducting qualities of the phenolic board, the current required from a negative supply such as this is usually at a minimum and this type of construction is more than adequate.

The entire mini-supply is housed in a standard 6 x 46 x 3 inch aluminum chassis. It is evident from the photographs that it's a little crowded, but there is more than eough room for all the components. The easiest way to put the supply together is to install the power transformer, choke, diodes and front panel controls first; then the filter capacitors are wired into the circuit. In this way the circuitry is built up in tiers and there is sufficient room to work. The available space may be more fully utilized by mounting the 90 volt reference diode and resistors associated with the 6AU6 voltage amplifier on a 7 pin turret socket (Vector type 8-M-9T).

In the several months that this supply has been in use, it has proven to be an invaluable adjunct to the workbench. In fact, like so many new tools, I often wonder how I got along without it!

. . . WA6BSO

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Origin of the Wireless Code

International Morse Code: the life-blood of CW men but a parasite to phones. Where did it come from? When did it start? Who invented it? Why? How does it differ from American Morse? What is "Continental"?

Confusion reigned on the high seas during the early days of wireless. A wireless operator who sailed in the American merchant marine from 1904 to 1907, states he used American Morse. An *American Morse* operator who left the sea in 1907 to work at the Telefunken station in New York City, will never forget the struggle to copy the first message: *"Continental" code in the German language.* The combination practically swamped him. Another operator, sailing out of Philadelphia in 1910, distinctly recalls using International Morse. In the Gulf, a former chief engineer at WNU, (Tropical Fruit's key station in New Orleans) tells about the "fun" the night American law required the Great White Fleet to switch over to *International Morse.* And David Sarnoff of the Radio Corporation of America says he used "Continental" during the Titanic disaster of 1912 when he handled messages between the rescue ship Carpathia and Wanamaker's New York City store where he worked. *All speak the truth.*

Foreign ships used International Morse. Nevertheless, problems hounded them too. It took an International Wireless Telegraph Conference held at Berlin in 1903 to get nations to agree to exchange messages between ship and shore stations using rival equipment, *to agree to give preference to calls for help,* and to set a fixed scale of charges for messages. At a second Berlin conference held in 1906, twenty-seven nations met and agreed to use the International Morse code and adopted SOS for the distress signal. (English ships used CQD and the Germans SOE). The United States sat in at the 1906 conference too, but the Senate never ratified the treaty. America's ships continued with both codes.

Operators who learned the code at American Marconi schools, transmitted in International Morse. Telegraph operators who switched to the sea, sent American Morse. Naturally, many American ships couldn't communicate with each other let alone with the foreign fleet. At the London Convention of 1912, nations created the "Q" signals and again tried to establish International Morse as the sole code. Once more the United States attended and the Senate procrastinated. Not until the Titanic, England's "unsinkable" luxury liner, struck an iceberg on her maiden voyage and sank, did the United States act. On July 1, 1913, International Morse became the universal wireless code.

The early codes

If you don't like the code, don't blame wireless; blame the telegraph. Wireles didn't create International Morse, it only adopted it. International Morse code existed fifty years before Marconi spanned the Atlantic with the letter "S" on December 19, 1901. It grew out of American Morse.

Dot-and-dash codes originated with the electromagnetic telegraph. The first dates back to 1838. It occurred as a result of the Morse/Vail experiments that lifted electricity out of the

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.
	Bacon.	Rees.	Swaim.	Schilling.	Gauss & Weber.	Steinheil.	Original Morse.	Later Morse.	European Morse.
	1605.	1809.	1829.	----	1833.	1836.	1838.	1844.	1951.
A	aaaaa	11111	t	rl	r	lrl	sss	sl	sl
B	aaaab	11112	tt	rrr	ll	lrrl	ss ss	lsss	lsss
C	aaaba	11121	ttt	rll	rrr	llr	s ss	ss s	lsls
D	aaabb	11122	tttt	rrl	rrl	rl	sss s	lss	lss
E	aabaa	11211	s	r	l	l	s	s	s
F	aabab	11212	ss	rrrr	rlr	lrr	s sss	sls	ssls
G	aabba	11221	sss	llll	lrr	rrl	ss s	lls	lls
H	aabbb	11222	ssss	rlll	lll	rrrr	ssss	ssss	ssss
I	abaaa	12111	ts	rr	rr	r	sl	ss	ss
J	----	12112	t tts	rrll	----	r	ss s	lsls	slll
K	abaab	12122	t t	rrrl	rrr	llr	lsl	lsl	lsl
L	ababa	12211	t tt	lrrr	llr	rll	l'	l'	slss
M	ababb	12212	t ttt	lrl	lrl	rrr	lss	ll	ll
N	abbaa	12221	t tttt	lr	rll	rr	ls	ls	ls
O	abbab	12222	t s	rlr	rl	lll	ss	s s	lll
P	abbba	21111	t ss	llrr	rrrr	rllr	sssss	sssss	slls
Q	abbbb	21112	t sss	lllr	----	----	ssls	ssls	llsl
R	baaaa	21121	t ssss	lrr	rrrl	ll	s s	s ss	sls
S	baaab	21122	t ts	ll	rrlr	llrr	sls	sss	sss
T	baaba	21211	tt tts	l	rlrr	lr	lls	l	l
U	----	21212	tt t	llr	lr	rlr	sll	ssl	ssl
V	baabb	21221	tt tt	lll	rlr	rlr	l	sssl	sssl
W	babaa	12121	tt ttt	rlrl	lrrr	rlrl	ssl	sll	sll
X	babab	22212	tt tttt	lrlr	----	----	ll	slss	lssl
Y	babba	22221	tt s	rllr	----	----	sl	ss ss	lsll
Z	babbb	22122	tt ss	rlrr	rrll	rrll	sls	sss s	llss

Fig. 1. Comparison of the early alphabetic codes with the final International Morse code created by the Germans.

laboratory and put it to work. At last the world possessed the means for rapid distant communication; communication dependable day or night regardless of the weather. A triumph of simplicity itself, American Morse survived well over a hundred years in telegraph systems of the United States and Canada. It provided careers for thousands, a hobby for thousands more, and set the foundation for amateur radio.

Construction of the American Morse code undoubtedly benefited from the alphabetic codes available at the time. A number existed. One goes back to the ancients 150 years before the Christian era. The Greek historian, Polybius, in the tenth book of his General history, describes a bi-signal method of signaling over a distance by torches. He credits Cleoxenus and Democlitus with the invention and himself with its perfection. The scheme divided the Greek alphabet of 24 letters into five series or tablets with each (except the last) containing five letters. One to five torches exposed on the left side indicated the group or tablet; similar torches raised on the right side indicated the place of the letter on the tablet. Slow and useable only at night, distance depended upon weather conditions and the resolving power of the receiver's eye.

Non-alphabetic systems got messages across much faster. Roman armies used the heliograph; the African, the tom-tom; the American Indian, smoke signals. Reflected sunlight flashing off polished shields, conveyed battle instructions to Roman legions and spread deeper fear among defending armies. Tom-tom rhythms, haunting as the drums in Ravel's musical classic "The Bolero," aroused the jungle and sent cold chills up and down the spines of white traders in slaves. Puffs of smoke floating lazily above surrounding peaks, forecast a kind of trouble that raised hair on end as pioneers in Conestoga-wagon caravans trespassed Indian lands to settle the American West. Again, weather affected each. Subject to sunlight, daylight, or wind conditions, these systems could convey only limited intelligence.

Galileo's telescope gave birth to a much faster system—the semaphore. Using it, Claude Chappe, a French engineer produced a practical system that sent messages all over France. Above simple towers holding a vertical wooden post, a horizontal beam pivoted controlled by ropes. At the end of the beam, two vertical

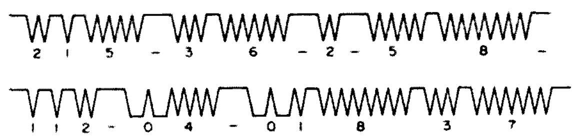

Fig. 2. Example of constant-line message produced by Morse's first telegraph machine. The receiving operator numbered the "V's" between spaces. By comparing the groups of numbers with a numbered dictionary, he deciphered the message. An inverted "V" represented a zero. When the zero came before a number or group of numbers, the operator read the number as an actual number not a word.

LETTERS

A	- —	J	— - — -	S	- - -
B	— - - -	K	— - —	T	—
C	- - -	L	— —	U	- - —
D	— - -	M	— —	V	- - - —
E	-	N	— -	W	- — —
F	- — -	O	- -	X	- — - -
G	— — -	P	- - - - -	Y	- - - -
H	- - - -	Q	- - — -	Z	- - - -
I	- -	R	- - -	&	- - - -

NUMERALS.

1	- — — -	4	- - - - —	8	— - - - -
2	- - — - -	5	— — —	9	— - - —
3	- - - — -	6	- - - - - -	0	————
		7	— — - -		

PUNCTUATION.

Period	- - — — - -	Exclamation	— — — -
Comma	- — - —	Parenthesis	- — - - —
Semicolon	- — - — -	Italics	— - - - —
Interrogation	— - - — -	Paragraph	— — — —

Fig. 3. The alphabet of Revised Morse; the code used in telegraphy throughout America and Canada.

arms moved. Movement of the three members produced a large number of configurations which a viewer at the next tower read through a telescope. When in 1852 the electric telegraph replaced the semaphore system, a network of 556 semaphore stations covered France stretching over a total distance of 3000 miles.

England used a different scheme. The visual system installed by the British Admiralty between London and its naval bases consisted of 15 towers each supporting a horizontal board that contained six circular holes opened and closed by shutters. A round-trip test run over the London to Plymouth circuit covered the 500-mile route in three minutes—170 miles a minute. A tremendous speed at that time, but a speed dependent upon daylight and clear weather. In the United States, the first semaphore system connected Martha's Vineyard with Boston in 1800.

For speed and maximum intelligence, inventors turned to alphabetic codes. **Fig. 1** shows a comparison of nine. Probably the first five-unit, even-letter code of record appears in Francis Bacon's monumental work, "Advancement in Learning" published in 1605. It antedates Morse by over 200 years. Bacon's code used two letters; "a" and "b". By juggling them around through five positions, he obtained thirty-two differences—far more than the twenty-four required for the alphabet then used. (J and U didn't appear in the alphabet at that time)

In volume eight of Dr. Abraham Rees' Cyclopedia published in 1809, a signaling alphabet similar to Bacon's appeared using numbers instead of letters. This code included symbols for letters "J" and "U". The first nine letters of the alphabet followed exactly the notation of Bacon. After injection of the letter "J" which takes the same symbol as Bacon's "K", the remainder of the alphabet from "K" to "V" inclusive follows regularly the arrangement of Bacon's but shifted two letters downward. Only the symbols for "X", and "Y", and "Z" differ. See columns I and II of **Fig. 1.**

James Swain of Philadelphia in 1829 published "The Mural Diagraph, or the Art of Conversing through a Wall." Sometimes designated the *prison code,* the symbol "t" signifies an audible tap or knock, and the "s" an audible scratch. Swain failed to use the simplest combinations of taps and scratches possible. He gave five signals to "N", "R", "T", and "W" and six to "X" when combinations of only four could suffice to make characters. Also, byt adopting the "numeral system," Swain could not escape using awkward, spaced letters in two-thirds of the alphabet. Column III shows this code.

Baron Schilling of Cronstadt, a Russian counselor of state, used the low potential cell of Alessandro Volta and the galvanometer of Luigi Galvani to develop a telegraph system moving an upright pointer to the left or right of a fixed position. His code consisted of combinations of the letters "R" (right) and "L" (left) as shown in column IV. Five letters of Schilling's code appear in the International Morse code.

Gauss and Weber of Germany introduced a telegraph system in 1833 that used an "r" and "l" code of unequal length. A simple plus or minus dot made up the binary combinations. Steinheil expanded upon their system. He also used the "r" and "l" method but his equipment made dots upon a ribbon of paper from small becks holding ink. Two rows of dots appeared, one to the left and one to the right, looking very similar to a modern cable signal record. Like Schilling and Gauss, Steinheil gave short symbols to the letters appearing most often in German. In a paper published in Sturgeons "Annals of Electricity" in 1839, he anticipated reading telegraphy by ear.

American Morse

Professor Samuel Finley Breeze Morse solved the telegraph problem by not expecting too much out of a primary circuit. His first apparatus, however, bore little resemblance to the final system put into operation between Washington and Baltimore May 24, 1844. Neither did the code.

Morse's patent disclosure dated October 3, 1837, showed a pendulum holding a pencil in contact with a moving strip of paper. *A continuous line appeared on the paper.* Pieces of cast type containing 1 to 9 raised points, (equal to the numbers they represented) fit into a hodler when composed to form a mes-

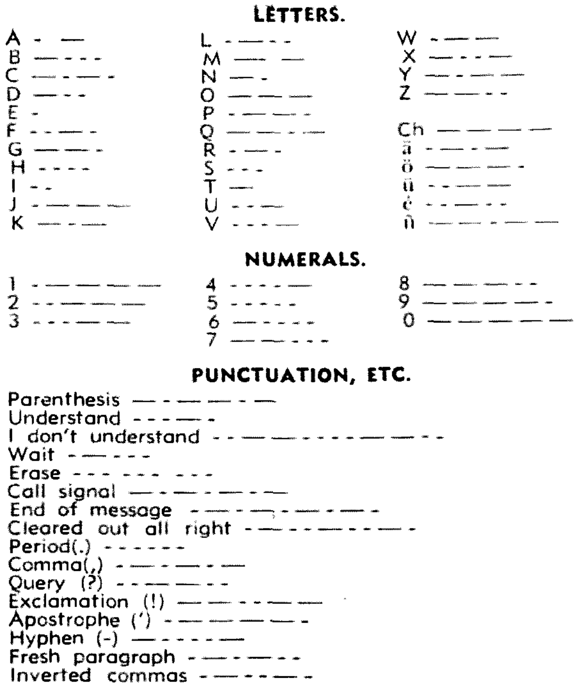

Fig. 4. The International Morse code used universally in wireless since July 1, 1913, and throughout the World in telegraphy except for America and Canada.

sage. As the holder moved forward, the points on the type worked a lever up and down which regulated the times and intervals electricity flowed to an electromagnet mounted on the pendulum. When energized, the electromagnet moved the pendulum sideways and a spring pulled it back. Each action zig-zagged the line making a series of spaced "V"s on the paper. *As the machine could not break the continuous line, it could not produce dots and dashes.*

The code Morse devised to work with this machine required a dictionary suitably prepared with numbered words. By counting the "V"s and observing the space arrangements, the receiver obtained groups of numbers which he deciphered by means of the numbered dictionary. See **Fig. 2.** An inverted "V" represented a zero; if it appeared before a figure or group of figures, one read the group as an actual number instead of a word. Numbered codes existed long before this one. Both optical and semaphore telegraphs as well as naval signals used them. But Morse's system produced a permanent record. Speed averaged about five words a minute.

After a laboratory demonstration in September 1837, Morse hired Alfred Vail of the Speedwell Iron Works at Morristown, N.J., under contract. Then came big changes. At an exhibition of the telegraph at the New York City University on January 24, 1838, the electro magnet no longer operated a pendulum; *it moved a horizontal bar.* Each time it moved *a dot or dash appeared on the moving strip of paper.* And the operators, working directly in the language, reached a speed of 10 words a minute. The demonstration marked the first use of a dot-and-dash code and communication by means of an alphabet.

The original dot-and-dash code named after the Morse telegraph instrument, appears in column VII of **Fig. 1.** Morse's patent application of April 7, 1838 and the patent issued June 20, 1840 contain it. This alphabet transmitted language in words and sentences for the first time. The general plan used the simplest and shortest combinations of symbols to represent the most frequently recurring letters of the English alphabet. In this code, "G" and "j" took the same symbol as did "i" and "y" and "s" and "z". Also, the code included seven broken letters.

Morse and Vail didn't use this code when they opened the Washington to Baltimore telegraph line in 1844. They used revised Morse: the code that opened careers to thousands over the next 100 years. This code incorporated the folowing basis:

The dot	1 unit
The dash	3 units
The space between the elements of each letter	1 unit
The space between two letters	3 units
The space between two words	6 units

Fig. 3 shows the complete alphabet of the revised Morse code used in telegraphy throughout the United States and the Dominion of Canada. Revised Morse contains six spaced characters: C, O, R, Y, Z, and &. This arrangement secured economy of space and consequently of time. No letter, except "j", exceeds 5 dots or 9 units, and frequently used letters in the English language contain the fewest and shortest elements. Numerals kept within a six dot or eleven unit restriction to distinguish them more easily from the letters.

Revised Morse became a high-speed code in the hands of professionals. Glamorous careers sprang up everywhere. Speedy operators transmitted blow-by-blow descriptions direct from ringside. Others watched big-league baseball games and fed the play-by-play action into newspaper lines. Some traveled West with the railroads. Some died in the middle of a message manning dangerous frontier outposts deep in the Indian lands. How fitting the first message sent by Morse—a message composed by the daughter of the U.S. Commissioner of Patents: "What hath God Wrought!" Morse's

harnessing of electricity soon brought the telephone, a cable linking Europe with America, electric light, an amplifier tube, and *wireless.*

International Morse

When you transmit in International Morse, you use four letters from Original Morse and eleven from Revised. The remainder come from the best of various European codes. Developed on the European continent where it got the nickname "Continental," International Morse became the universal code for wireless but never for the telegraph.

Austria and Germany share responsibility for the "Continental" code. Austria adopted the Morse apparatus after the Emperor saw a demonstration in 1845. Three years later two Americans built a 90-mile line conecting Hamburg with Cuxhaven. Earlier, the Bavarian Government adopted Steinheils's slow system and installed a short line between Munich and Augsburg. Several of the North German railroads used Wheatstone's equipment.

When the Austrian Government appointed Steinheil to organize the telegraph systems of that empire, he met in Vienna with representatives of the German states of Prussia, Bavaria, Wurtemburg and Saxony in October 1851. After scrutinizing all systems and all codes, the delegates unanimously adopted the superior Morse apparatus but not the code. They never wanted any part of spaced letters.

From the code of Dr. Clemens Gerke, a telegraph engineer of Hamburg, the Vienna telegraph convention selected letters C, F, L, and R. Steinheil's code furnished O and P. Letter X and numerals 1, 2, 3, 4, and 5 came from M. Lefferts' code introduced on the American Bain lines in 1849 as did also 6, 7, 8 and 9 though arranged in reverse order. By this arrangement the first half of the five-digit number act as a check on the second half. Other sources supplied letters J, Q, Y, and Z leaving 15 to come from revised Morse.

Besides the regular 26 letters of the alphabet, International Morse contains 32 other characters. An accented "e" and the apostrophe satisfy the French language, the ä, ö and ü the German, and the ñ the Spanish. The period consisted of six dots sent in three groups of two. This stood until September 1, 1939. At the Cairo International Radio Convention in 1938, the delegates agreed to change the period to the symbol used for the comma. This satisfied telegraph companies whose printers produced it as three "i"s. The symbol for the exclamation mark then became the comma. (Telegraph operators never used the exclamation mark except to abuse each other within the law. A half dozen !!!!!! expressed ironical admiration of another operator's stupidity). See **Fig. 4.**

England switched to the Continental code when cables laid in 1854 and 1855 connected the British Isles to Holland, Germany and other European countries. Like the Americans and Canadians, English operators didn't want to change; however, they soon succumbed to pressure. Each operator received a copy of the new alphabet with two months grace to learn it. When the day for the change arrived, the company found many not ready. Granting of another month produced the same result. Not until the company *gently* promised a reduction in pay for those not ready by the end of a third period did the new code go into operation.

Adventure trailed Morse's telegraph as it moved eastward from the business countries of Europe. At army outposts in India, dangerous excitement awaited British operators and sometimes a saber in the back. The British call the code "Morse." Others think of it still as "Continental." But the gain in international scope as the Morse telegraph spread, caused the "Continental" moniker to diminish in favor of "International Morse."

. . . W2AAA

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Understanding AVC

On most every communications receiver worthy of the name, you'll find a small knob labelled "AVC-MVC" or something of the sort. On the newer ones, the label is more likely to read "AVC: Fast-Slow-Off."

Experienced operators use this control more or less by instinct. The newer hams more often tend to leave it set in one position permanently and ignore it. But chances are very few of us, experienced or not, really understand what's behind that knob—and why.

Contrary to widespread belief, the AVC* circuitry in a receiver isn't necessarily just a "lazy man's gadget." While the original intent was to eliminate need for adjusting the receiver's gain controls when tuning from a weak to a strong signal, modern AVC does much more than that.

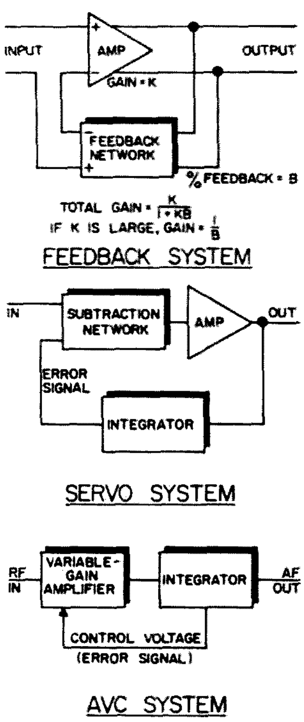


Fig. 1. AVC as a servomechanism.

For instance, in a SSB round-table a properly performing AVC system will make the fellow a continent away who's running a barefoot 10B sound almost exactly the same strength as the guy across town who's pouring the coal to a kilowatt. Neither will blast your eardrums, and more important, neither will overload the receiver to cause distortion products.

In CW net operation, a good AVC circuit will allow you to run full break-in, monitoring your own outgoing KW if you like while dragging in the 20-watt station in Podunk between your dits.

Don't misunderstand us. Not every AVC system will meet these standards. All too many, even in completely factory-built (and never modified) gear, fold up at one end or the other of the signal-strength range. But performance of this nature is not impossible to achieve, nor is it even particularly difficult once you understand just what the AVC circuitry does and how it works.

Feedback and servomechanisms

Let's look at the "how it works" first, before we get into the more complex matter of "what it does."

And to see how it works, we forget all about AVC and receivers and such for a spell and go

* Or AGC, automatic gain control, perhaps a better name.

back to some basic (although not too widely published) theory. This concerns "feedback."

Now in the ham vocabulary "feedback" is usually considered as something not too desirable, as when rf gets into the audio lines and a wild whistle goes out over the air. However, none of us could do a thing without it. Here's why:

Feedback, broadly defined, consists of taking a part of the output of a system and feeding it back to the input. (The name is almost obvious from its inclusion in the definition.) This part of the output can be fed back in such a way as to *add to* the input, or to *subtract from* it. If it adds, the feedback is called "positive," while if it subtracts, the feedback is called "negative."

Positive feedback is what causes the howls, unwanted oscillations, etc., which have made "feedback" a not-good term to so many of us. A very small input signal can be applied to an amplifier, and a similar but bigger signal comes out. If we now put some of this bigger signal into the input, adding to the original, we have an even larger original signal, and the output is still larger. The process keeps repeating until we have the maximum possible output signal, and the input signal no longer has any control. Even if the input signal is then removed, the amplifier will supply its own input from the fed-back portion of the output, and all you have is an oscillator.

If, however, the part of the output fed back is arranged to subtract from the input signal, then the original small signal is reduced still more, and all that the amplifier gets as input is the difference between input and feedback. While this may appear to be only a senseless waste of gain, consider what happens if we have some distortion in the amplifier.

In this case, the input may be pure but the output is distorted. The difference between input and output will contain all the distortion of the output, but in such a polarity that it will tend to cancel out the distortion introduced by the amplifier on its second trip through. The result is a significant reduction in distortion, due to the feedback.

All of which is basic to the idea of feedback, but doesn't tell much about how it helps us do things.Let's forget electronics for a moment and consider the application of feedback to a physical problem.

Assume that a pencil is lying on the table and you want to pick it up. You start your hand moving in the direction of the pencil. As your eye registers the distance from hand to pencil, it feeds back to the brain to inform the arm muscles that the distance is becoming less and less, and when the distance is zero

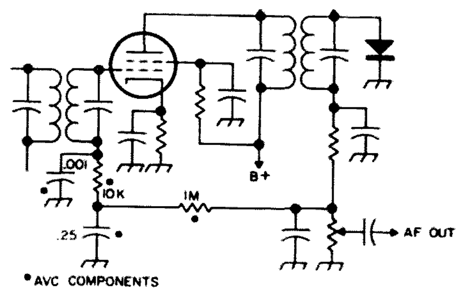


Fig. 2. Simplest AVC.

(hand on pencil) the feedback tells your arm to stop moving.

To test it, try to pick up the pencil blindfolded. Chances are very great you'll knock it to the floor the first 100 times.

Of course, all this feedback takes place on an unconscious level, and we never really realize it's going on. However that doesn't change the fact that feedback is necessary to human activity.

The basic negative-feedback principle can be applied in many ways, as has just been demonstrated. One way of applying it—which was actually the way your brain applied it to the hand-and-pencil problem—is to use the feedback to develop an "error" signal, and the "amplifier" of the system to adjust conditions so that the error signal has the smallest possible value.

Naturally, the error signal can never be reduced to zero. Should this happen, then the feedback would also be zero and the system would cease to function. However, the error signal can be made to get about as close *to* zero as you like—say about 1/1,000,000 volt in

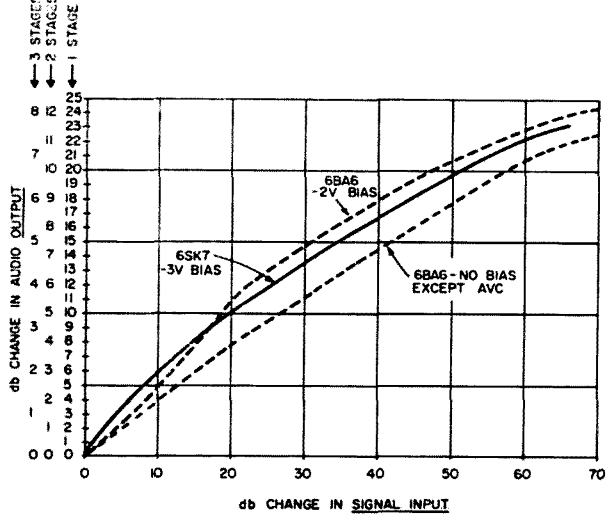


Fig. 3. Control curves for 6SK7 and 6BA6; typical for all remote-cutoff pentodes.

CQ, CQ, CQ, CQ, CQ, . . .

an electrical-feedback system. But we're a bit ahead of ourselves.

This error-signal approach to feedback is usually known as a "servomechanism" and is in itself an entire branch of applied science. Within that science, three different classes of servo-mechanisms are recognized. Type O is defined as that class of servomechanisms designed to hold the *output* of a system constant with varying input; Type I is that class which varies the output as a control signal varies (such as aircraft servos which develop tons of pressure from the mere touch of the pilot's hand on a control); and Type II is a class which holds the rate of change of output con-constant with varying input.

Of these, we're only interested in Type O, since it's identical to the definition of a basic simple AVC system. The basic simple AVC is designed to hold the output volume constant with changes in RF signal input.

Simple AVC systems

Fig. 1 shows some block diagrams illustrating these points. As signal input to the receiver

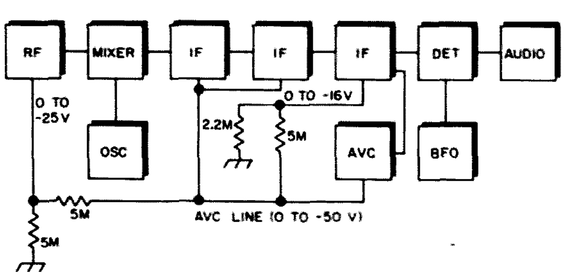


Fig. 4. Application of partial AVC.

increases, the "error signal" developed by the AVC circuit also increases. This "error signal" is then applied to the receiver in such a manner as to reduce its gain, and with the gain reduced the output signal tends to be reduced also, thus offsetting the increase in input signal.

Since increasing "error signal" reduces receiver output, while increasing input signal increases output (in the absence of AVC) it's easy to see that the feedback is negative. And since the net effect of all this is to attempt to hold the output constant with varying input, it's also easy to see that this is a Type O servo-mechanism.

Note, though, that we can't use the audio output of the receiver "as is" for an error signal, for this would tend to wipe all the modulation off the input signal. We must process the error signal so that it reacts only to changes in input over a period of time which is long compared to individual audiofrequency cycles.

Fig. 2 shows one way of doing this, which was the original AVC circuit. The carrier is rectified at the output of the *if* amplifier to obtain a negative dc voltage, which is then filtered and fed back to the grids of the *if* stages to reduce their gain. This is convenient, since the same diode which rectifies the carrier for AVC can also detect the signal for audio, but it falls far short of perfection.

To find out why, we must examine in more detail the purposes of AVC circuitry.

Purposes of AVC

First, of course, is the obvious one of letting the operator's volume-control hand rest as much as possible.

Of equal importance, though, is the avoidance of overload in all stages of the receiver. Surprisingly, it's not always the final stage which overloads first. Many modern receivers suffer from *mixer* overload long before the *if* chain is in any danger of getting too much signal.

Speed of reaction is another purpose for AVC as opposed to manual control. No operator living can twist a knob fast enough and accurately enough to have full receiver gain in the spaces between dits at 40 wpm, while reducing gain sufficiently to keep from overloading with the local transmitter's signal when the dits and dahs are going out. For electronic circuitry, capable of operating in billionths of a second, it's a lead-pipe cinch.

Now for any AVC system to approach perfection it must score high on all three counts.

That is, it must hold output-level variations to a minimum through a wide range of input signal levels, it must prevent all stages of the receiver from being overloaded, and it must be capable of reducing and restoring gain as rapidly as the operator desires.

In addition to this, though, there are a few more points a top-notch AVC system must meet as well. It should *not* impair the receiver's sensitivity to weak signals, which means that the AVC should *not* work on very weak signals, but instead should turn itself on when the input signal passes a certain level. While reacting rapidly, it must not react so rapidly that it wipes the modulation off an incoming signal. And finally, it must not create distortion on its own, by biassing amplifier tubes into non-linear portions of their operating curves.

Satisfying all of these requirements, of course, takes quite a bit of design, and frankly we're not going to try to put it all down here. The idea at this point is to make it understandable, not incomprehensible!

AVC for constant output

So let's start with the requirements one at a time, in order. Let's see how we can keep the output variations to a minimum.

Assume that our input signal is expected to vary from 1 microvolt to 1 volt. That's a million-to-one range, which when we put it into db of voltage variation comes out to be 120 db.

If we set out to hold the output completely constant, this means that we must vary the gain through the receiver by 120 db also. For instance, with 120 db of gain and a 1-microvolt input signal assume we get a 1-volt output to the final audio amplifier. With a 1-volt signal, and the receiver gain reduced to 0 db by a 120-db-controlling AVC, we still have a 1-volt signal driving the audio output. The audio volume would be the same.

However, the gain of a single-stage *if* amplifier is rarely in excess of some 46 db, which means we would have to have 3 stages of *if* merely to be able to vary the gain at least 120 db.

And for completely constant output, the error signal would have to reduce to zero at both ends of the line—which won't do. So let's see what happens if we allow 6 db of output variation.

The control range required now is 120 (input signal) minus 6 db (output variation allowed) which equals 114 db. We still need those 3 *if* stages.

So with 114 db of control required, and 3

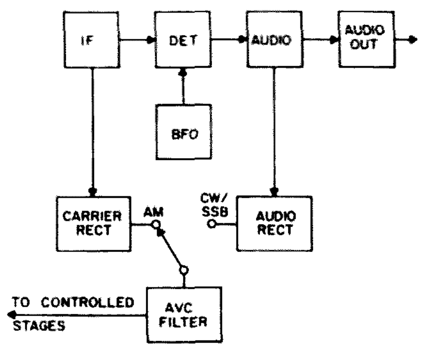


Fig. 5. Audio/carrier AVC hookup.

stages to get it in, we find that we must vary the gain of each stage by 114/3 or 38 db. Let's assume that the gain with no control voltage applied is 42 db; this gives us a total *if* gain of 126 db or approximately 2 million times.

This means our 1-microvolt input signal will come out as approximately 2 volts.

If we increase our input signal to 11.22 microvolts (21 db greater) and leave the gain unchanged it would give us an 11¼-volt output signal to the detector. However, we don't want the signal at the detector to exceed 4 volts (6 db greater than the no-AVC condition) which means the gain must be reduced somewhat. If it is reduced to 35 db per stage, a reduction of 7 db, we will get an output of 2¼ volts.

Now let's hit the amplifier with a full volt input. To have 4 volts output, the total gain must be reduced to 12 db, which is 4 db per stage.

At this point, let's look at some figures developed along the way. With 2 volts at the detector, our control voltage was zero. With 2¼ volts out, we had a control voltage reducing gain by 7 db per stage. And with 4 volts out, the control voltage reduced gain by 38 db per stage. Thus in the first ¼ volt of control, we were reducing gain by 28 db per volt, while at the other end of the control range we were reducing gain only 19 db per volt.

And tubes (or transistors either) just don't like it that way. They tend to change gain at a relatively constant rate. The 6SK7, which used to be standard for *IF*-amplifier service, had an average gain-change rate of about 1½ db per volt. At −3 volts, it had maximum gain, while to reduce this gain by 41 db required 29½ more volts of bias.

Since our original specifications allowed us only a 2-volt range from no control to full control, and practical tubes work with a 30-volt (approximately) range, something was obviously wrong with our original specification. The trouble was that we wanted performance too close to perfection.

In practice, we can expect the working range of an AVC system to be about 1/2 to 1/3, per controlled stage. That is, with a single controlled stage the variation in ouptut will range from 1/2 to 1/3 of the input variation (60 db input change results in approximately 20 db change of output; 20 db input change results in about 10 db output change).

If we have two amplifier stages on control, the output variation will be cut in half. With 60 db input change, the output level will change only about 10 db.

With three stages controlled, the variation drops to 1/3. 60 db variation of input gives only about 7 db output change. By increasing the number of stages under control, we can keep reducing the output variation, but a practical limit is reached eventually. Nobody wants to put 100 amplifier stages into a receiver simply to get output constant within 2 db for a 60-db variation in input!

And it probably wouldn't work right anyway.

In case you're interested, **Fig. 3** includes the single-stage control graph for the 6SK7 and also for the 6BA6, more representative of the newer tube types now in use.

AVC for overload protection

Which fairly well disposes of point 1. How about point 2—over-load protection?

As mentioned a bit back, to get wide control range the control voltage must be made fairly large, and not all tubes can take it. This isn't of importance particularly with a factory-built receiver because we assume the manufacturer's engineers took this into consideration, but it does stand to warn us not to substitute *IF* tubes unless we know exactly what we're doing.

In particular, a sharp-cutoff tube should *never* be used to replace a remote-cutoff type. The S-meter may read higher on noise, and it may even read a bit higher on some signals, but the chances are rather great that the substitution will play havoc with the AVC action of the set. You may find that the S-meter just

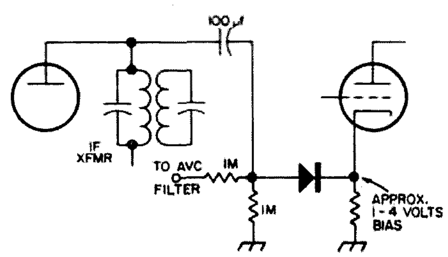


Fig. 6. Simple delayed AVC.

sits there hovering around 9, with almost no change between a weak signal or a strong one. You may not even hear the weak signals. What happens is that the sharp-cutoff tube amplifies set noise up to the point where the AVC takes hold, then cuts off at that amount of AVC voltage, so that stronger signals don't get by and weaker ones are highly distorted.

Even substituting another remote-cutoff tube should be done only with care, because the transfer characteristics (linearity to you sidebanders) of the different types at similar bias voltages is quite likely to differ. That 6SK7 may be there for a reason; possibly no other tube can handle the particular level of input signal at high values of AVC voltage.

Normal design procedure to prevent overload is to first select tube types which can handle large values of voltage while having high grid bias applied; for instance, a typical communications receiver may be called upon to furnish a 66-volt swing at the output of the final *if* stage, wrile the stage is biassed to some 20 volts negative. This is a rough requirement. It it can't be met, about the only thing to do is to leave the final stage *off* the control line, which then restricts the range of control you have available. Already we're compromising.

Next is to estimate the control voltage produced by various input signal levels, and check to see that each stage can handle it's voltage requirement at that level of control voltage. If things are arranged so that the *first* controlled stage overloads before any of the others, you'll satisfy the overload-protection requirement—but this is seldom practical to do.

Incidentally, while AVC is usually omitted from rf stages to keep from hurting the signal-to-noise ratio, it's about the only way to prevent mixer overload. A point usually overlooked is that the AVC, if properly designed, won't affect the rf stage gain until the signal is already strong enough that there's no worry about S/N ratio!

In applying the control voltage to the complete amplifier chain, it's frequently helpful to use only part of the control voltage on some stages. For instance, the rf stage may get only 1/3 of the control voltage. If control voltage ranges from 0 to 30 volts, that on the rf stage may range only from 0 to 10 volts. This frequently gives protection for the mixer, while helping make sure S/N ratio isn't reduced until a signal is particularly strong.

Fig. 4 illustrates one way to get partial control, and shows also application of similar partial control to the last *if* stage to protect it against overload. This can be carried on to the point of applying full control to only the first

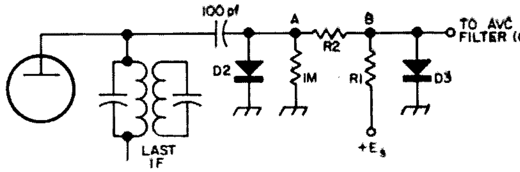


Fig. 7. Sinking diode AVC circuit.

if stage, a little less to the second, etc. However, doing it this way will reduce the control range below that indicated by Fig. 3, so the compromise should be made on the basis of what *you* want more.

Reaction time

And now we're down to point 3, reaction time. This is more frequently referred to as "time constant". Like control range, it involves many factors.

On one hand, we never want reaction so fast as to wipe any audio off an incoming signal. At the other extreme, we don't want reaction so slow that the receiver takes hours to adjust itself. Our desired reaction time is somewhere in between.

To find out what its *practical* limits are, let's look first at the area of wiping-out-audio. If we want to preserve all audio frequencies above 100 cps, the fastest our system can be allowed to react is 1/100 second (1/f), or 10 milliseconds. If we don't care about anything below 300 cps, we can reduce reaction time to 3.3 milliseconds. For "broadcast quality" response to 30 cps, however, reaction time minimum is 33 milliseconds.

What this means is that if our AVC system can reach the desired control voltage in 33 milliseconds when signal increases, or drop back in the same time if signal drops, it will just cancel out a 30-cps tone on the incoming signal. For actual broadcast-receiver use, a time constant of ¼ to ½ second is more commonly used.

But we're not so much interested in BC as in communication. Let's see how fast the reaction time must be for CW. If we intend to operate at speeds up to 50 wpm, this means the spaces between dits will be only about 40 milliseconds wide. If we intend for the receiver to have usable response during this time, the AVC system must react in less than 1/10 of this time, which gives us a reaction time of 4 milliseconds for high-speed CW.

Since this will also suffice for 300-cps response to audio, it might appear that a 4-ms reaction time for both initial response to increased signal and for drop-off with reduced signal would be good.

But how about SSB? In this mode, we want to hold average gain constant throughout a word at least—and 4-ms reaction wouldn't do this. To fill this need, circuits known as "hang" AVC circuits have been devised, which charge rapidly but hold the control voltage in place for a while after the signal drops again.

Which brings us to the "Slow-Fast-Off" knob on the modern receiver. Ideally, the complete system for today's use should have a uniformly fast (4-ms or so) charge time, with a choice of either equally rapid release time (fast) or a much slower release, on the order of ½ to 1 second.

In practice, many receivers consider 100 milliseconds fast. These can usually be improved by changing resistors or capacitors as necessary to reduce the charging time constant by a factor of 25, but in doing so care must be taken that nothing else is changed. For instance, reducing a series resistor by 25 times might drop voltages throughout the system so much as to make it stop working, and reducing the filter capacitor by 25 times will usually shorten the "slow" time constant as much as it will the "fast."

However, if the "fast" and "slow" positions use two different capacitors, the "fast" capacitor can be made smaller as desired. We'll get into this a bit more down the road a spell, with schematics, but first we have some more points in design to dispose of.

Delayed AVC

Next on the list is that AVC should *not* reduce sensitivity. In a simple AVC system such as that of **Fig. 2**, any input signal at all (no matter how weak) would result in some control voltage, which would in turn reduce receiver gain. This is not good.

To overcome it, the AVC system is so arranged that no voltage is developed until the input signal exceeds a specified value. This is called "delayed AVC" but contrary to the implications there is no *time* delay. The delay is a matter of *voltage*. A wide variety of circuits has been developed to introduce the "offset" action; we'll look at some a bit farther on.

Distorition from AVC

The final point to be considered in designing the perfect AVC system is that the AVC should introduce no distortion of its own.

The point was partially considered when examining control range, but there's more to it still. When the AVC runs the amplifiers down near cutoff, a phenomenon known as "modulation rise" takes place which introduces second-harmonic audio distortion if a modulated signal is being received. While the signal is still quite audible, it sounds quite "mushy." If your receiver sounds perfect on weak signals but all signals above S9 are a bit distorted, modulation rise is quite possibly present.

When voltage delay is introduced to satisfy point 4, then a type of distortion known as "differential distortion" may come along with it. This type of distortion results from the AVC coming into action part way up the waveform on a weak AM signal, but in practice has not been found to be appreciable unless modulation at the 100-percent level is being received. If 100-percent modulation is being detected, similar distortion will also be generated in the detector, so differentail distortion can be considered merely a fine point of AVC engineering.

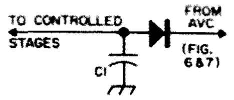
Sources of AVC voltage

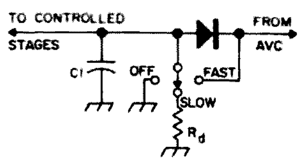
You may note that so far, except for **Fig. 2**, we haven't mentioned just *where* in the receiver the control voltage is derived. This is because the control can be developed from either of two sources, and when all factors are taken into consideration either works equally well (or equally poorly if you prefer the negative connotation).

Most conventional, of course, is the practice of using rectified carrier voltage as in **Fig. 2** for the control. This approach lends itself well to AM use but is a bit sticky for SSB and CW since the incoming "carrier" is intermittent at best and may not necessarily bear any relation to the actual signal strength. For example, the sentence "his sis is 5" consists entirely of dits and spaces. If a steady carrier would be coming in at 10 microvolts, the *average* voltage for the duration of this sentence would be less than 5 microvolts, and the AVC would treat it as a 5-microvolt carrier. On the other hand, the sentence "Tom to Ø" is all dahs and spaces, so would be closer to 7½ microvolts average.

To overcome these problems, many designs have taken AVC control voltage from the *audio*, after detection but before the gain control. With SSB and CW, this gives equally good results, and in many cases proves superior, since there's no worry about bfo energy getting into the AVC line and hurting receiver sensitivity.

However, with AM it's again sticky. If all signals were modulated 90 percent or so, an





Right, Fig. 8. Hang diode hookup. Left, Fig. 9. Switching release time with the hang diode.

audio-AVC system for AM could be made reliable, but the audio recovered from a 100-microvolt carrier with only 10 percent modulation and from a 10-microvolt carrier modulated 100 percent are about the same. The system can't tell which is which. If amplifier gain is set to be right for 10 microvolts, then the 100 microvolts will overload it. And if it's set for 100 microvolts, the gain may be too little for the 10 to get through.

One of the most satisfactory answers is to provide *two* sources of control voltage, one taken from the carrier for AM and the other from the audio for other modes, and to choose between them with the receiver's function switch. How this is done is shown in **Fig. 5**, in block-diagram form.

Practical AVC application

By now, you may be wondering "How can I put some of this data to use on my own receiver?" Here are a few circuits which will serve as starting points for your modifications. It must be emphasized that they are starting points only. Before plugging in a soldering iron, warm your receiver up and make some measurements. You'll need to know the grid voltage is on each controlled stage with antenna disconnected, what the voltage is when a "S9 + 100 db" signal is coming through, and what the dc output of the detector or AVC diode now in the set is under each of these conditions. Write 'em all down, for you'll need them along the way.

The circuit of **Fig. 6** provides delayed AVC, using only the cathode bias across any convenient audio tube to obtain the delay voltage. As shown, the first af tube is included in the same envelope as the two diodes, but this isn't necesary. In fact, semiconductor diodes of either the germanium or silicon varieties may be used.

Delay voltage will be determined by the bias on the tube, and until the incoming signal produces more control voltage than this the control line will remain at ground potential. If bias is set at 2 volts, AVC voltage will be zero until the control voltage exceeds 2 volts, and then will be equal to control voltage minus the 2-volt delay.

Returning 1-megohm resistor R2 to a source of negative bias voltage will establish the AVC voltage at the level of this bias, but will also reduce the delay voltage by the same amount. You can use this to set a minimum 1-volt level on the AVC line, with 2-volt delay, or whatever you want, and get rid of cathode-resistor problems in the *if* chain; such an approach was used in the BC-779.

A more complex delayed-AVC circuit known as the "sinking diode" hookup is shown in **Fig. 7.** This one eliminates all differential distortion and allows the AVC action to be tailored to almost any circuit requirements, but is more complicated than most. Here's how it works:

To start with, let's assume that D3 isn't in the circuit. Let's also assign some values for Es, Ed, and consequently Rl. Es might well be 150 volts from a regulated supply, which Ed (the delay voltage) could easily be 5 volts. Then if R2 is set to be 470K, Rl will be 14 megohms.

Now, with no signal input, point A will be at ground potential, while the voltage at point B will be that developed by the voltage divider R1 and R2 in series from the 150-volt source, or about 4.89 volts positive.

When the voltage at point A drops to −5 because of incoming signal, the voltage across the divider becomes 155 (from +150 to −5) and the voltage at point B becomes 5.02 positive, in comparison with that at point A. Since point A is −5, the resulting voltage at point B with respect to ground is 5.02 − 5, or 0.02 volt.

As signal increases and the voltage at point A becomes say −25 volts, the voltage across the divider becomes 175 and the voltage at point B becomes 5.79 volts positive to that at point A, or −19.21 volts to ground.

When the voltage at A goes to −50 volts, that at B will be −43.5. As the voltage at A becomes more negative, the percentage difference between B and A becomes less.

In this circuit, the delay voltage may be set to any desired value as shown in the illustration. The larger Es is made, the less percentage reduction of control voltage will be introduced by the R1-R2 voltage divider. However, if the ratio is made too high you may have difficulty locating suitable resistors for R1 as few distributors stock anything larger than about 22 megohms.

So far, we have been ignoring the action of D3 and of CI. D3 prevents the AVC line from ever going positive, by conducting and clamping the line to ground whenever its plate is more positive than its cathode. If you

would prefer to have the line clamped at some value of standing bias such as −1 or −2 volts, simply returning the cathode of D3 to such a voltage instead of directly to ground will accomplish this.

C1 is the filtering capacitor, and its value will determine at least the charging time constant of the system. The other component of this time-constant network is R2. The value of C1 should be chosen after R2 is selected, so that the product of C1 in microfarads and R2 in megohms is equal to the desired charing time constant (0.004 if the 4-millisecond recommendation is to be followed). To get a 4-ms charging time with our previous example, C1 should be 0.0087 μf. This is not a standard value; you could use an 0.0082 in parallel with a 500 pf, or probably just a 0.0082 or an 0.01 alone with little real error.

As shown, the discharge time will be longer than the charge time, since the discharge path includes 1 megohm in series with R2 (the high resistance of R1 prevents it from having much effect in rapid discharging of C1). If a 0.01 μf unit were used, the discharge time constant would be 0.0147 second, or 14.7 ms, too slow for CW and too fast for speech.

Discharge time can readily be lengthened by adding a diode in series with the capacitor as shown in **Fig. 8**, so that no discharge path is provided except by the leakage across the capacitor (this can't be done if divider resistors are used to give partial AVC to some stages as discussed earlier since they will allow more rapid discharge). However, the only practical way to shorten discharge time in this circuit is to modify component values in a multi-way compromise. The simplest way to make the compromise is to make C1 small enough that discharge time falls to the desired value; in our example this would be 0.004 seconds/1.47 megohms, or 0.0027 μf. Charge time would now be only 0.0027 × 0.47 or 1.28 milliseconds. This, however, is no particular disadvantage.

At this stage, the circuit can be converted to fast-slow switching as shown in **Fig. 9** by adding a diode and paralleling it with a switch. With the small value used for C1, a 0.5-second discharge time constant can be obtained by using a 185-megohm resistor at Rd in **Fig. 9**—and this amount of resistance is undoubtedly present in switch and circuit leakage. In fact, you may have trouble getting that long a discharge time with no physical resistor at all for Rd. This, incidentally, is the basic "hang" AVC approach.

Before getting into how to modify only the though, let's look at one more AVC circuit. This one employs dc amplification of the control voltage after detection, for a wider range of control than would be possible otherwise. The circuit appears in **Fig. 10.**

In this one, the delay voltage is set by choice of resistor RL in the cathode circuit of V1. So long as the voltage developed across the 1-megohm resistor in V1's grid circuit is more positive than cutoff voltage for V1, the cathode voltage of V1 will be positive. With this voltage positive, diode D1 will be reverse-biassed and cannot conduct, so the AVC voltage will remain at zero.

When signal is applied and D3 rectifies it, a negative voltage is developed across the 1-megohm resistor. When this negative voltage approaches the cutoff value for V1, the cathode voltage of the tube will move toward the negative-supply level, and when V1 cuts off the cathode will assume the negative level of the negative supply.

This forward-biases D2, which conducts and allows the negative voltage to appear on the AVC line.

If signal level is only enough to supply say a 10-volt negative value across D3, the AVC voltage can be made much greater by proper choice of tube type for V1, of negative supply voltage, and of R_L. With a 150-volt negative supply and a tube which will cut off at −10 volts between grid and cathode, the AVC line can be made to go to virtually the full −150 of the supply.

Note that D2, D3, and V1 can all be a single duo-diode/triode tube such as the 6AT6 or 6AV6, while detector diode D1 can be any semiconductor type. This means that, though the circuit appears more complex than most, it actually requires only a few more components than does the simplest of AVC arrangements. The negative voltage supply can be obtained from the regular power supply through a capacitor and shunt diode as shown in **Fig. 11.**

Now let's look at the time-constant or reaction time situation with an eye to possible modification of your own receiver. **Fig. 12** shows a typical AVC setup, with the actual time constants of your own AVC system,

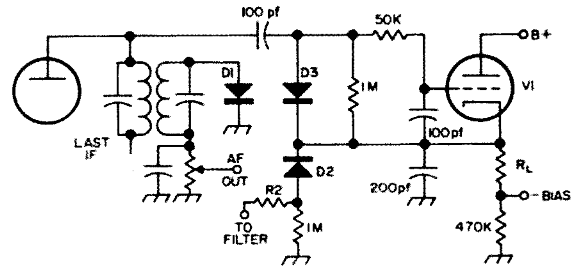


Fig. 10. DC-amplified delayed AVC.

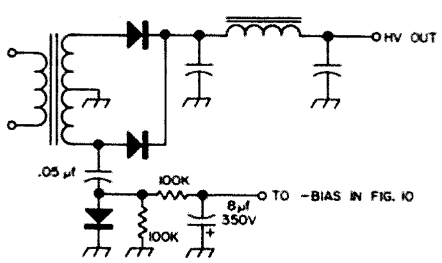


Fig. 11. Bias supply for circuit of Fig. 10.

control-voltage takeoff and rectifiers indicated merely by a block. You can compare this to the schematic of your own receiver to determine which components correspond on your own schematic.

You can see that our earlier discussions assumed that reaction time was determined *entirely* by R4 and C4; this isn't quite true. The formulas shown in the figure include the effects of all resistances and capacitances in the circuit. If more stages are under control than the three shown here, their decoupling networks can be included by adding R7,C7 in the same way that the underlined R6, C6 are included here (for two-stage control, omit all underlined components in the formulas).

While R4 and C4 still predominate in the control of reaction time, with the typical values indicated on the schematic the R4-C4 time constant was lengthened by some 2.4 milliseconds on charge and by 42.65 milliseconds on discharge.

To reduce these other effects, you can replace all decoupling resistors (R5, R6, and filter resistor R1) with RF chokes, and reduce the associated bypass capacitors to somewhere near 100 pfd. A shorter discharge time constant can be achieved by adding a parallel resistor (Rp) as shown in dotted lines, but this resistor together with R4 will then form a voltage divider which will keep full AVC from being applied to the line. Reducing the value of C4 will shorten both the charge and discharge times; you may find it possible to reduce the value of C4, add Rp, and modify the value to R4 to equalize charge and discharge times. Then adding a diode as shown in dotted lines gives you an option of short or long discharge time; with the diode in the circuit, discharge time will be long.

In making these modifications, refer to the chart of "normal" AVC voltage levels you prepared before starting, and be certain that you end up with the same voltage on the AVC line for the same signal input that you had in the beginning. (Of course, if you had overload problems too you might want to use a little less or a little more, but if the control was satisfactory and all you want to change is the reaction time then you must be certain that you get the same control voltages out after making circuit changes.) These measurements should be made only with steady signal applied, because even the 11-megohm input resistance of a VTVM will drag off any charge on C4 if it is made small.

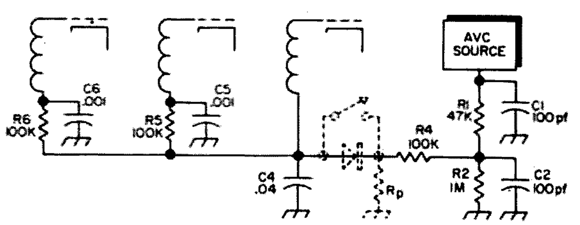
The same considerations, of course, also apply to the substitution of any of these AVC circuits for that existing in your receiver. The final voltages applied to the AVC line of the receiver must be a fairly close match to the original voltages if undistorted, completely controlled output is to be achieved.

Not yet mentioned has been the use of the AVC voltage to control other functions such as anl bias-setting or squelch circuits. If the AVC is to be so used, it's a good idea to include some form of dc amplification such as the circuit of **Fig. 10**, with an additional diode connected in the same manner as D2 for each of the additional functions. This will prevent undesirable interaction between the functions, and will prevent them from having any effect upon the AVC circuit itself. For economy reasons, such isolation is not usually provided in factory-built gear.

From this point on, AVC design becomes more of a detailed engineering study than a general survey subject. If you care to pursue it further, a good starting point is the "Radiotron Designer's Handbook" available from Radio Bookshop. Look in Chapter 27. An additional reference is K. R. Sturley's book "Radio Receiver Design," Part 2, Chapter 12, if you can locate a copy—it was published in London in 1943.

But for a general understanding of the subject, additional reading shouldn't be required. And now, at least, you should know what that little knob on the panel does when you turn it!

. . . K5JKX



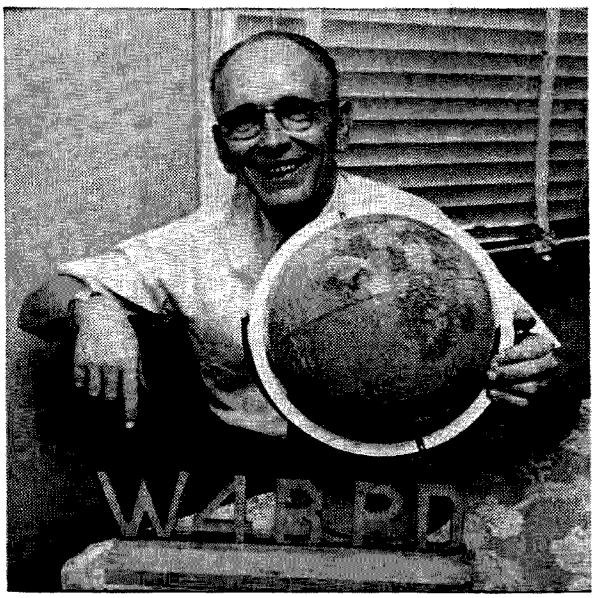
Formulae:

Charge time constant (seconds) = R1(C2 + C4 + C5 + **C6**) + R4 (C4 + C5 + **C6**) + R5C5 + **R6C6**

Discharge time constant = **C6(R6 + R4 + R2)** + C5(R5 + R4 + R2) + C4 (R4 + R2) + C1(R1 + R2) + C2R2

Resistances in megohms, capacitances in microfarads. With typical values shown for components, charge time is 6.38 milliseconds and discharge time is 46.647 ms.

Fig. 12. Time-constant considerations of AVC circuit.



Gus Browning W4BPD
c/o 73 Magazine
Peterborough, N.H. 03458

Why WTW Now?

Details on 73's NEW Work the World Certificate for DX'ers

I suppose some of you are wondering why another DX award at this time. The answer to this is very simple. This is not **another** DX award, this is **the** DX award. Don't call it just another DX award. DX awards come and go but this is the one that will stay with us, because it's the one award (the only one I know of) that will make you keep on your toes to stay on top.

Basically the WTW award is an award that either phone or cw stations can qualify for. They are both completely separated, there will be no mixing of the two together. If you want a phone award you will have to be in there on phone and work phone stations. The same goes for CW. Each band will stand on its own feet. There will be awards for 10 meters, 15 meters, 20 meters, 40 meters, 80 meters and even 160 meters. Each QSL card will have to indicate the band, mode, time, date, QTH, and signal report. For statistics we would even like to have the signal report sent and received indicated on each QSL card. This is not necessary but would be preferred. We will try to have a certification point in as many countries as possible under the jurisdiction of a National Club. How about some volunteers from you clubs overseas?

The first WTW certificate requires 100 verifications to be submitted. The second certificate for 200 countries verified, then 300 for the top and the real WTW certificate for 350. What's beyond the 350 country certificate is not known at this time. Maybe even a Moonbounce certificate or one for Satellite relay later on if anyone ever works the required 100. This will be an award that intends to stay up to date. We are in the process now of getting "country lists" from the various clubs overseas. We will begin by using the ARRL country list and others will be added on as the suggestions are received from the overseas groups. I don't think the list will ever get up to 400 countries, but it surely will be over 350. 73 Magazine will keep you informed, so watch 73 magazine very closely for all announcements from now on. Of course the certificate will be one of the nicest and you will be proud to hang it on your wall. To cover our handling and mailing costs please enclose a one dollar bill. Overseas stations will be allowed to enclose seven IRC's to cover costs.

This DX award commences at 0001 GMT, May 1st, 1966. All cards must have this date or a later date to certify for WTW. Until we announce the various certification places send your cards to: Gus, 73 magazine, Peterborough, New Hampshire. South American sta-

tions can send theirs to the Venezuela Radio Club, P.O. Box 2285, Caracas, Venezuela, South America. Later on there may be other clubs for other portions of South America. We will keep you well informed in 73 Magazine about the verification points.

At the end of the first 5 years (from May 1 to 31st. Dec. 1966 will be considered the first year) your total will go down each year if you don't QSO the countries you worked 5 years before. WTW will be an award for *active* DXers. The top country totals will be listed in 73 Magazine. News about the WTW will of course be written about in 73 magazine.

Watch for W4BPD on these frequencies at these times for latest info about WTW:—14065—1400 GMT, and again at 2100 GMT (this is CW) 14275 + or − 1500 GMT and again at 2200 GMT (SSB). Starting about July 5th. Of course if I am out of my QTH at these times I will not be on. I would like to gather DX information and be able to give it out also during these periods of operation. I have even been thinking (but not seriously) about a weekly DX bulletin later on. How about a post card from *everyone* who would subscribe to such a thing?

New comers have mentioned to me many times that they have no chance to ever get caught up with the old timers. The WTW will be run by DXers for DXers—not 75 meter rag chewers, 80 meter traffic handlers, or phone patchers. We know what DX is and what the DXers want. I think we will give them what they want with WTW. The overseas groups have always looked upon the DXCC as an American award and some of their opinions vary considerably from ours as to what they think is or is not a country. We think they will like the WTW and will look upon it as something they have a little sayso in since they will at least have a chance to help select the countries to be included in the WTW country list.

I have had many complaints about QSL cards that were mailed to the USA for verification apparently becoming lost or even stolen. When we have our overseas certification points selected we think this type of a complaint will practically cease, or at least will be considerably lessened. I think we all will admit that we need as much activity as possible on every band right now, because of the next frequency allocation conference that will be coming up soon. You can bet that all of our frequencies are being eyed by the various services as possible good hunting grounds. Oh yes, we are being surveyed very carefully and all the wide open frequencies that we don't use will certainly be mentioned when this frequency allocation conference takes place.

To help keep the commercials out of our bands *please* pick out one of them when tuning up, checking your keying, checking your SWR, testing, etc. And then there is no law that says you can't call CQ on their frequency. Sign your call every ten minutes to satisfy our FCC. Of course run ***full*** power during these times, I mean ***full*** power. We must fight fire with fire and many of them can be discouraged if enough fellows share their frequencies. Wayne has the right idea about this. Maybe a planned operation of this sort might some day come about—who knows. I myself would like to keep our frequencies clear and this is one way to at least start clearing them up. More *power* to you all on this suggestion. Remember some of that RTTY around 14090 to 14100 is Ham, so don't do your monkey business on top of them. It would be real nice to have a RTTY receiver to be sure of fellows around these frequencies.

Future DXpeditions by me—oh yes things are moving nicely along these lines. Another thing, I want to sort of wait a while to see what the WTW boys will be needing and also what will be included in some of the overseas suggested country lists. By July I'll know better what you fellows will be needing.

WTW is not in competition with any other award. I think that DXCC has had their day, WAZ has had theirs, the WPX has sort of slowed down (with some fellows it never even got started) and from now on the WTW will take their places—and keep it for a long time.

We at 73 Magazine want everyone of you to know this is your award. We are always open to suggestions from the gang, and if it's a good one it will most certainly be considered. As for myself, I am for anything that will make you fellows happy. By this I mean the DXers. Of course DXing is not the only thing in Ham Radio. You fellows who like Rag Chewing, Contest operating, phone patching, testing out new antennas or equipment—you keep right on doing what you like. I am for you 100 percent. Can you picture the bedlam in our bands if everyone was a DXer? I myself think the DXer is *tops*—he has to have good equipment, good antennas, be a good operator, know geography, and be on his toes all the time to keep up with the other DXers. Good luck to you all on the WTW. I wonder who will get certificate Number ONE for each band and each mode?—LET'S GO FELLOWS AT 0001 GMT MAY 1st, 1966.

. . . W4BPD

A. J. Bivens K5BEC

Private Listening Speaker

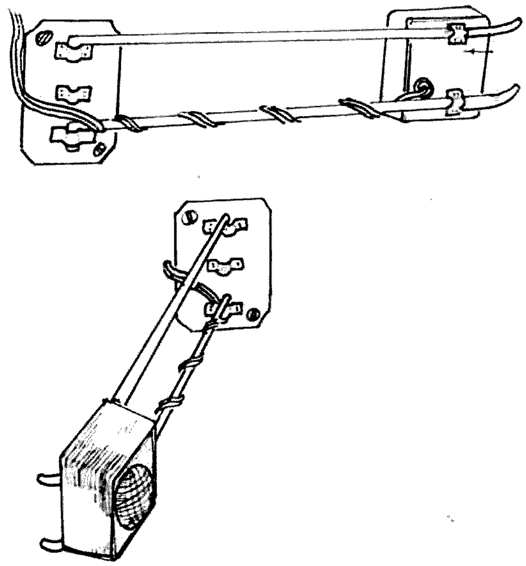
Ever wanted to keep the noise level down in your mobile station while other members of the family are trying to sleep, talk, or listen to the car radio? Have you ever wanted to hang a small speaker close to your ear so you wouldn't have to wear an ear phone and keep tangling in the cord?

Well, here is a device that has worked very well for the writer. It consists of a miniature back seat speaker (Lafayette order No. 99G6122) which may be ordered or purchased from most electronic stores, and a 59 cent cup towel rack purchased from a dime store.

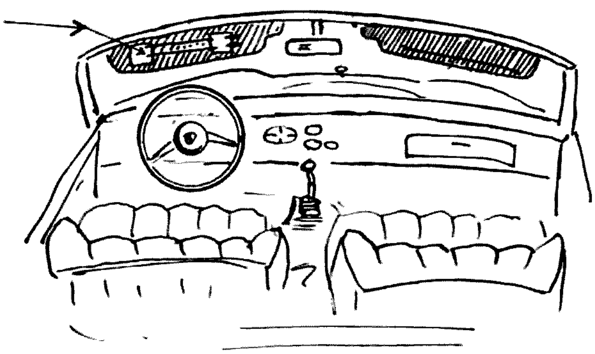
If the rack has more than two bars they should be removed for better side vision. Mount the assembly as diagramed making sure to mount it on the side of the visor facing driver when visor is down. The speaker may then be swung out when needed or folded back and then lifted up with the visor when not in use. Lateral adjustment is done by swinging the rack and vertical adjustment by pushing or pulling the visor slightly at the bottom.

A heavy rubberband may be permanently installed around the visor end near the speaker for holding the speaker against the visor when visor is in use but the speaker is not.

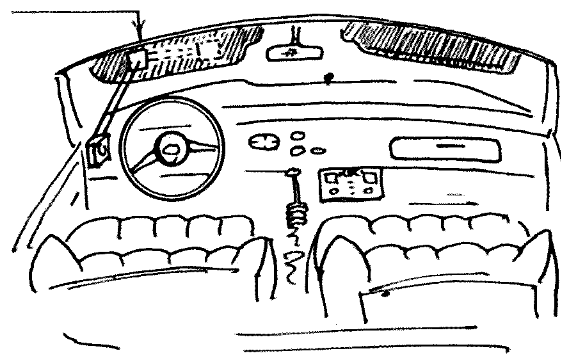
. . . K5BEC



Views of the private listening speaker.



The private speaker out of use against the windshield.



The speaker in use for private listening.

NEWS FROM THE INSTITUTE OF AMATEUR RADIO

Compiled by A. David Middelton W7ZC, Secretary

IoAR constitution approved by Members

A Report was mailed to all Members of record in early February. Due to a delay in production of the Report at 73, the deadline of February 10th for the return of ballots on the Constitution and By Laws came shortly after mailing from Peterborough. A post card extension notice to all Members the first week in February established the new date of March 10th for receipt of ballots at IoAR HQ.

Here are the results of the voting on the ratification of the IoAR Constitution and By Laws.

Total votes received	233
Votes of approval	228
Votes of disapproval	5

The Constitution and By Laws as presented in the Members Report of January 1966 is thereby ratified by a majority of the votes cast, and the approved C and BL are now in *effect*, as of *March 12, 1966*.

Several Members sent in suggested amendments or changes. There being no mechanism for such changes *at this time* it is suggested that Members reconsider their desired changes and re-submit them later, prior to the first Board meeting. A call to Members will be issued at that time for such amendments to be considered as provided for under Article 12 of the IoAR C and BL.

QST young IoAR members

You may win prizes in a construction-article contest specifically designed for IoAR Members under 20 years of age! See March or April IoAR columns for complete details. Deadline for receipt of written entries is July 15, 1966.

More on tower suit

March 73, page 72, informed you that a Pennsylvania Amateur had been forced, at the order of the State Supreme Court to dismantle his tower and antenna. This unfortunate Amateur, W3HJ, recently wrote IoAR HQ. Here is the pertinent part of his note.

"Thanks for the offer of help but don't know just what you could have done. I think I got just about all of the legal and financial support that I could have expected. In fact a good deal more. ARRL gave me wonderful assistance in both the local court and the Supreme Court of Pennsylvania.

"Since this suit was filed against me on the basis of deed restrictions and not zoning laws the chance of my winning it was not too good. There were some aspects involved though which made it seem advisable to try.

"I followed it through to the end more in consideration of Ham Radio as a whole than from winning it for myself as I would have been moving to another location in the future even if I had won the case.

"*I was just too trusting a soul from a verbal approval stand point.* As you say, read the fine print and with a fine tooth comb."

International hamfest July 16-17

IoAR Member Withey, WAØHUD informed HQ that an international hamfest is planned for a location on the border of Manitoba and North Dakota. Watch this column for further details.

Educational Amateur Radio

Project EAR, a person-to-person exchange of information and ideas via Amateur Radio has been cooperatively developed by Mr. Edgar Klugman, Principal of the Harrison (N.Y.) Avenue School, and Mr. C. Robert Fine WB2LUM.

Since 1964 Project EAR has successfully brought together school groups in distant points for direct child-to-child discussions of their respective locations, climate, and customs.

Also, panels of educators in New York have held joint meetings with similar panels in Australia utilizing the techniques of Project EAR, over cooperating Amateur Stations.

Mr. Klugman asked IoAR for assistance in obtaining volunteers in the Amateur ranks who are seriously interested in helping him enlarge Project EAR into a world-wide operation.

IoAR applauds this vital concept in the use of Amateur Radio. Project EAR has tremendous significance both in the field of international relationships (with resultant benefit to all Amateur Radio) and in is rewards to cooperative Amateurs in bringing this project to its potential worth!

If you are desirous of assisting, write Mr. Edgar Klugman, Principal, Harrison Avenue School, Harrison, New York, or to WB2LUM for complete information.

IoAR commends Mr. Klugman and WB2LUM for the originality of Project EAR and for their devotion to the cause of international friendship by extending the horizons of school children and educators through the organized use of Amateur Radio!

Technical examination questions needed

IoAR HQ is experiencing difficulty in securing assistance in the preparation of questions for its Certificate of Merit examination as described in the March column. If you are *qualified*, and wish to aid in this worthwhile project, please write IoAR HQ.

IoAR—Totally Dedicated to the Betterment and Preservation of Amateur Radio.

Get it in writing and read the fine print

An amateur (who gave his call but it is being withheld) in a large eastern city wrote IoAR recently—"When I moved into this apartment a few months ago, I was told that I could put up an antenna. But when I attempted to put one up, my landlord said NO. He soon changed his mind, however, but demanded $500,000 (WOW) insurance. I am allowed a TV antenna (in the lease—which does not state the size) so I will use the stacked TV antennas as my ham antenna!"

Moral—get it in writing—and watchout for the fine print. $500K—that's probably more than the building cost!

FCC continues study of Docket 15928

IoAR HQ recently inquired of FCC regarding the status of Docket No. 15928, and asked for the name and call of the new Chief of the Amateur Division. Here is FCC's reply, dated Feb. 15, 1966.

"At the present time, the Commission is carefully studying the comments that were submitted in response to the Notice of Proposed Rule-Making in Docket No. 15928. Further action in this Docket is anticipated sometime this year.

"Mr. Everett Henry (W3BC), presently Chief of the Marine Radio Division, has been reassigned to serve as Chief of the Amateur and Citizens Radio Division.

"Signed—Ben F. Waple
Secretary"

Changes in Members QTH

All IoAR Members are urged to keep Membership Department, Peterborough, N. Hampshire fully informed as to their *correct, up-dated* mail address, complete with Zip code. Do *not* send this information to IoAR HQ, but *do* send it to Peterborough!

IoAR member heads important emergency net

The West Coast Amateur Radio Service has been in daily operation for almost three years. A group of dedicated and highly skilled operators maintain a continuous watch on 7225 kHz, ready to handle any type emergency, priority, routine message or information to be passed among the seven Western states.

A daily practice (and traffic) drill is held at noon, PST, with formal net proceedure.

Direct contact is maintained by WCARS with highway police and similar public safety and welfare services.

IoAR Member David Atkins, W6VX, is President of WCARS and often NCS for the drill or during the daily monitoring. IoAR Secretary W7ZC is a Director of WCARS and a frequent participant in network operations.

Amateurs in the Western part of the US are invited to call in on 7225 at any time the WCARS can be of any help.

IoAR commends these and other amateurs who devote much of their operating time to highly valuable public service.

Important IoAR Addresses

For all correspondence except that regarding membership and supplies:
Institute of Amateur Radio
Springdale, Utah 84767

For membership correspondence and IoAR supplies:
Institute of Amateur Radio
Peterborough, N.H. 03458

Ham-CB cooperation effective in Texas

This column carried an inquiry (in March) concerning possible Ham-CB joint efforts. IoAR HQ received the following information from Gene Nowlin WA5JPW;

"Here in Marshall, Texas, this has been in effect for about two years, under Civil Defense, Marshall Amateur Radio Club, Inc.—(WA5MRP) and the Caddo District CB Radio Club under a CD50 unit call of KKV2461.

CD Communication Director—Bert Wood K5MVJ; Co-ordinator, Cliff Crabtree W5NYW-10Q1495 who is also President of Marshall ARC; President Caddo District CBRC—Vernard Grimes—WA5MNF-KKV6996.

The amateurs handle some traffic locally on 10 meters and most all long distant traffic. The CB'ers handle all county as well as city traffic in the event telephones are out. We think it works out very well here in Harrison County, Marshall, Texas."

QTH? Lost members! Where are you!

IoAR HQ needs the updated, correct address of the following;

Davis, R.W. KB6CS
Livingstone, A.W. K6VYJ
MacArthur, Roger K9UYA
Miller, Chase. W. Jr. W4AXV
Nelson, Robt. L. K6ZCQ

Keep the news clips coming!

The response to HQ's appeal for news clippings concerning amateur radio has been excellent! Here is a project in which everyone can help! Watch your newspapers and magazines for any references to amateur radio, cut out the clips and send them to HQ. Please help fill HQ's Scrapbook!

Copies of constitution

With the ratification of the C and BL contained in the January 1966 Members Report this became an official document of IoAR. Members are urged to keep the January Report on file. The C and BL contain many pertinent facts about IoAR structure.

The Membership Department has been requested to include copies with all membership processing since Feb. 5, 1966.

Members who have not yet received their copy, please advise IoAR HQ.

. . .W7ZC

Hank Olson W6GXN
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Palo Alto, California

The Solid-State Product Detector

Increasingly, the use of solid-state circuitry is taking over in the field of electronics.

In amateur radio equipment, too, the "little three-legged gadgets" (transistors) are making in-roads. That solid-state ham gear has "arrived," is evidenced by several of the new SSB transceivers on the market, which use tubes only in the transmitter output stages.

There remain, however, a number of areas in commonly-used amateur circuitry, where transistors are awkward to use. For this reason, I suppose we shall continue to see *new* "all-tube" designs for some time to come. If a manufacturer decides on a tube-transistor "hybrid" circuit, he must face having two power-supplies: a high-voltage, low-current supply for tubes and a low-voltage, high-current supply for transistors. The expense of having two supplies for a "hybrid" design makes the two-faction system a near-reality—a company usually decides to either manufacture "all-tube" or "all-solid state." This means that *every* circuit block must be made solid-state (at least in the low power stages) before a manufacturer can seriously decide to join the "solid-state camp."

One of these "hard-to transistorize" blocks in our circuitry is the product detector, as needed for SSB reception. One obvious solid-state solution is the diode-ring demodulator, as used by Bell Telephone Laboratories, when SSB was first put into commercial service. The ring-demodulator is shown in **Fig. 1.** Of course, nowadays one would use a matched-quad of modern silicon-diodes instead of the original copper-oxide quad. The trouble with the ring-demodulator is that it requires diode-matching and a special balanced input system to be used. Also, a relatively large power level from the BFO is required to drive the ring, as the BFO current must drive the diodes of the ring well into forward conduction.

There are several double-diode product-detectors in amateur use, which are simpler to use than the full-blown four-diode ring-demodulator, but these are basically of the same family.[1,2,3]

Another amateur solid-state product detector is similar to the popular triode-tube

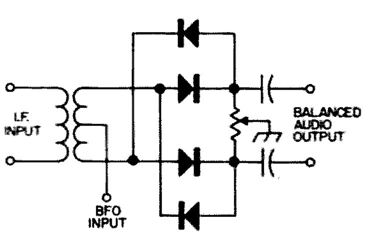

Fig. 1. The ring demodulator.

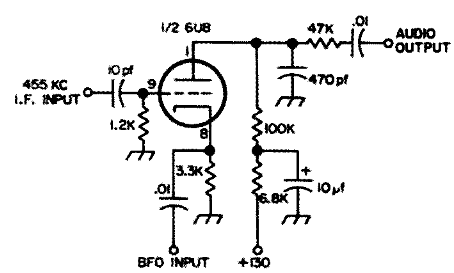

Fig. 2A. Triode tube product detector.

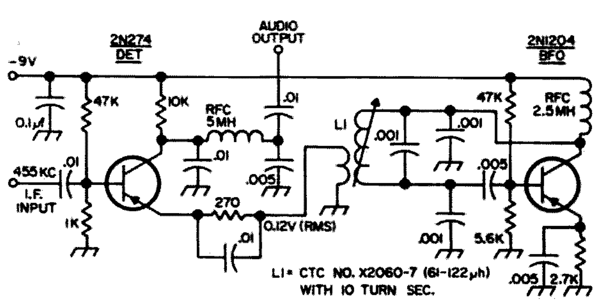

Fig 2B. Transistor version of the transistor product detector in Fig. 2A.

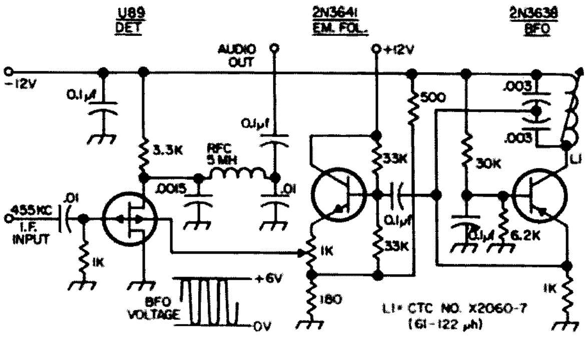

Fig. 3. Field effect tetrode product detector.

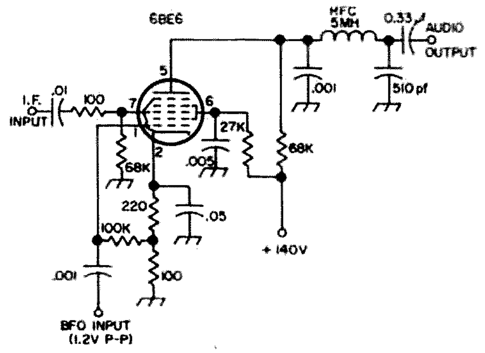

Fig. 4. Pentagrid product detector

type. **Fig. 2A** shows the essential part of the triode-tube detector and **Fig. 2B** shows its transistor counterpart.[4] Since the BFO drives the emitter, we again must deliver rather a large power level from the BFO (into a low impedance) to make the detector work. In fact, it is the rectified BFO voltage that biases this product-detector. When the BFO is turned off, the operating point changes considerably, and it is then possible to use the detector for AM. This product detector (the transistor version) is identical to most transistor mixers, and like them it cannot take large input signals.

The input-output characteristic of the circuit in **Fig. 2B** is shown in **Fig. 5**. If we define maximum useful output as the point on the input-output curve where the output departs from a linear relationship by 1 db, this circuit is only useful to 0.077 volts (rms) input. The curves were taken with the carrier-BFO difference frequency set at 2 kc. The input signal level was not increased above 0.12 v rms, because at about 0.13 v rms the BFO is "pulled" (injection locked) to the signal frequency. The use of an emitter-follower between BFO and product detector here would have allowed more complete measurements.

There remain, in the collection of tube-type product-detector circuits we may use, two which would seem to have no obvious solid-state counterparts. They are the product-detector using a pentagrid mixer, and that using a beam-switching tube. Each of these circuits has the advantage of having a pair of independent, high-impedance input ports, either of which will control the detector output current. This means that we get, at once, signal—BFO isolation, *and* small BFO input power requirement. But, unfortunately, the solid-state equivalent of the 6AS6, 6BE6, or 7360 hasn't been readily available; so no product-detectors along this line have been used in amateur circles to this author's knowledge.

Now, finally, at a price any ham can afford, a device is available to provide a solid-state product-detector with similar advantages to those of the pentagrid or beam-deflection tube types. The Siliconix U89, an industrial version of the 3N89 field-effect tetrode, is available for about $5.75, less than the cost of two 7360 Tubes. It is the fact that this FET has *two* gates, that are mutually independent, that makes it so useful.

In **Fig. 3** is shown the product detector using a U89. The second gate (G_2) is driven by the BFO and its emitter-follower. The emitter-follower gives BFO isolation and also, provides the proper bias level to the second gate. In **Fig. 5** is also shown the input-output curve of this detector. One will note that the output only deviates by 1 db from a linear relation, over an operating range of more than 65 db. About 0.5 v rms is the maximum signal input level, before linearity is lost.

In order for one to be able to make comparisons of the solid-state product-detectors shown above, a conventional 6BE6 product detector was constructed and measured. The

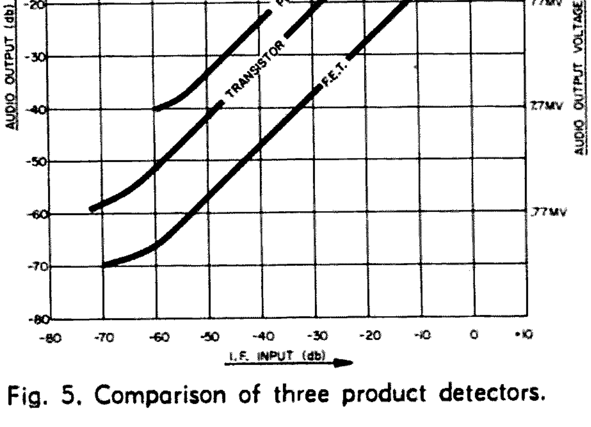

Fig. 5. Comparison of three product detectors.

circuit is similar to one used in one of the newer "amateur-band-only" HF receivers, but an additional L-C filter (5 mh and 510 pf) was added to cut down 455 kc in the output, and dc was used for the heater. These additions were to prevent the audio output VTVM from reading 455 kc or 60 cps, to either of which frequency it was sensitive. The 6BE6 product-detector circuit is shown in **Fig. 4** and the response curve is also shown in **Fig. 5**.

As can be seen, the useful ranges of the transistor, FET, and tube product detectors are respectively: 55 db, 67 db, and 58 db. The FET detector is clearly the best of the three circuits tried.

One note of caution is in order, however, since the FET product detector operates at an output level about 23 db below that of tube circuit. If this detector is to be used to replace the 6BE6 circuit in a receiver, an extra audio amplifier stage must be added.

. . . W6GXN

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2. Goodman, B. "The Misers Dream" *QST* May 1965, p. 13
3. R.S.G.B., *The Amateur Radio Handbook* 3rd. Ed. p. 93
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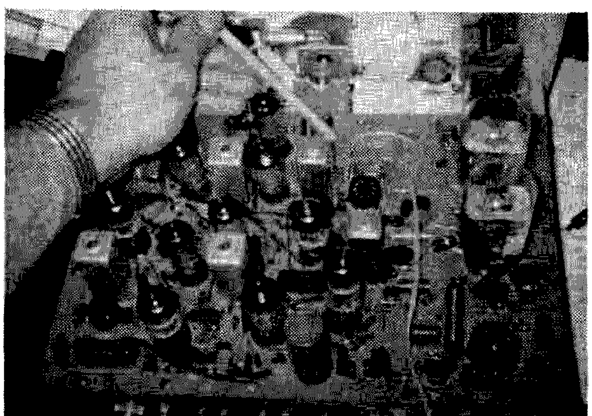
Put Your HW-22 on CW

It only takes a few minutes to modify this Heath SSB transceiver for CW.

I admire the Heathkit monoband SSB transceivers and feel that for the price, they are one of the best buys on the amateur market. Their only weak point is that they have no provisions for CW. However, the HW-22 can be put on CW very easily (and no changes in its appearance) by cathode keying the 12BY7 driver, V5 and by lowerlng the VFO frequency to the CW segment of the 40 meter band.

Modification

After pulling the chassis and turning the unit on its side, locate the driver tube V5 (12BY7). Carefully remove the grounded side of R52 (a 150 ohm resistor connected to pin 1, the cathode of V5) and solder a two foot piece of insulated hookup wire to the free end of R52. Next strip one quarter inch of insulation from another two foot piece of insulated hookup wire and tin its end. Insert the tinned end of the prepared hookup wire through the hole in the printed circuit board vacated by R52 and solder.



The keying line and connection are shown at the end of the pencil point. The 12BY7 driver has been removed for this picture.

Now locate the VFO coil L6. Moving the slug out will lower the frequency. It is easier to turn the slug from the bottom side rather than the top. Be sure C131, the main tuning capacitor, is fully meshed before turning the VFO slug. In my case turning the slug all the way out to the stop brought the frequency down to 7012 kc. After the adjustment of L6, the transceiver will now tune 100 kc or so of the bottom of the 40 meter band. Replace the cabinet and put the twisted two foot length of hookup wire through one of the holes in the cabinet. Connect the free ends of this hookup wire to a bug or key.

Operation

With the function switch in tune position, a DC voltage is applied to the balanced modulator to provide a steady output signal for transmitter tuning purposes, but since we have lifted the cathode of the driver V5 from DC ground, we are now able to key this output signal. To operate the HW-22 on CW just put the function switch in the tune position, close the key, load in the normal manner and start sending CW. To receive, just put the function switch back in the VOX position.

I have made many CW contacts with the HW-22 and all reports have been excellent with no signs or reports of clicks, drift or chirp. This modification can also be made to the HW-32 and HW-12.

To put the HW-22 back on SSB, just raise the VFO frequency back to 7200 kc and close the key. The modification for CW takes less time than reading this article.

. . . W7UXP

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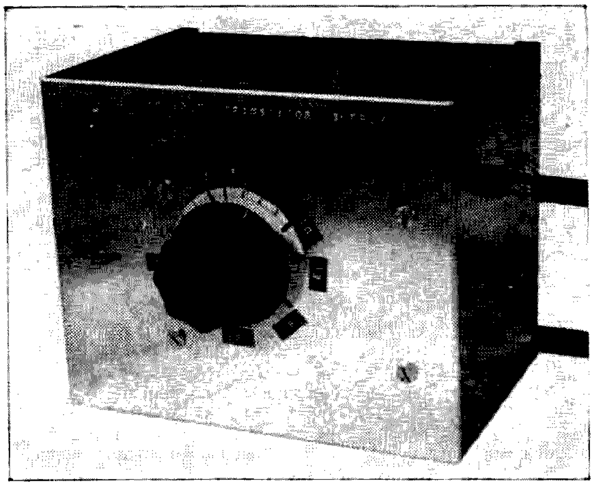
Haddon Heights, N.J. 08035

Variable Voltage Transistor Power Supply



I don't imagine I am alone when it comes to a spur of the moment decision to try out some new fangled transistor project (or something you have copied from Bill Hoisington using transistors) only to find you either have no batteries around or those that you do have should be buried with honors, having already served a very useful life. Rather discouraging.

Here is a transistor power supply for your bench or shack that is ready to go on short notice and simply needs an available AC outlet (**Fig. 1**).

This supply has operated in the author's shack for some time without any hitches and is rarin' to go on a minute's notice. All components are readily available from off-the-shelf stock of most any radio parts distributor, mail order houses (Allied, Lafayette and Newark) and in many cases out of your well stocked junk box. The transistor used in the supply is not an exotic and high priced type.

As noted in the schematic, this is a low voltage dc supply. Output is adjustable up to 18 volts. The maximum current at 18 volts is about 30 ma. On some lower voltages the current may run as high as ½ amp.

Some experimentation was required for R1, but after a few additions and subtractions it was found that 2000 ohms 2 watts did the best job for all around performance and smooth operation.

This was built in a 6 x 5 x 4" Mini-box (**Fig. 2**), but can be constructed in something smaller if desired. Originally it was contemplated using a meter with the supply, installed in the box, but not having a suitable meter handy at the moment, the project was completed without it. The calibration under the dial was made by hooking up a volt meter on a suitable scale and marking off the voltage readings convenient for work on my bench.

The circuit wiring is all between two eight point tie strips, one each side of the box. The rectifiers can be seen above the two 1000 µf capacitors. The 500 µf filter capacitor, between transistor base and potentiometer, is to the right in the photo. Using this supply on light loads, as presented by most transistor circuits, there is a slight drop of about 4 to 5%, but this is hardly noticable.

Since this supply is definitely not intended as a continuous replacement for batteries, but just as a handy bench supply for trying out various experimental circuits and during repair work on gear, its few faults are miniscule.

I feel the components have ample ratings and will suffice as compared with what would be taken from regular cells. A note at this point is worth mentioning. There is no heat sink used with the 2N301 as this would increase the total size by a considerable amount. Also note that the transistor is mounted on a small bracket (**Fig. 2**) made by bending a small piece of aluminum. Shoulder washers are used on the two bolts suspending the bracket to insulate it from the Mini-box, and a small piece of insulating material (bakelite in the author's case) is used between the bracket and case. The binding posts are also insulated from the case by using shoulder washers. Remember

WA2TOV is an avid homebrewer interested in UHF and SHF. He works at the inspection and testing department of Weathers Electronics and Development.

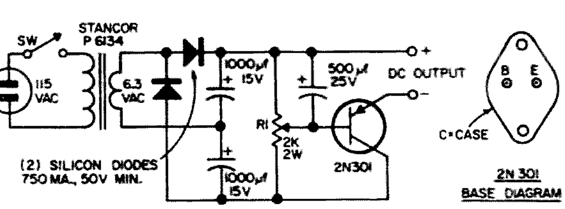


Fig. 1. Schematic of the transistor power supply.

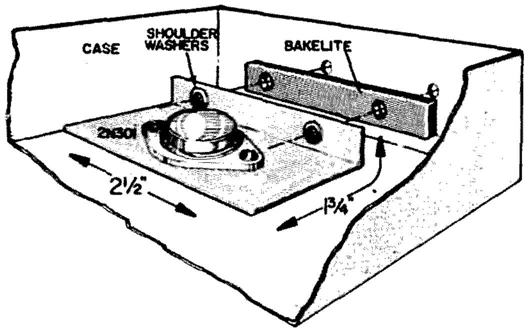
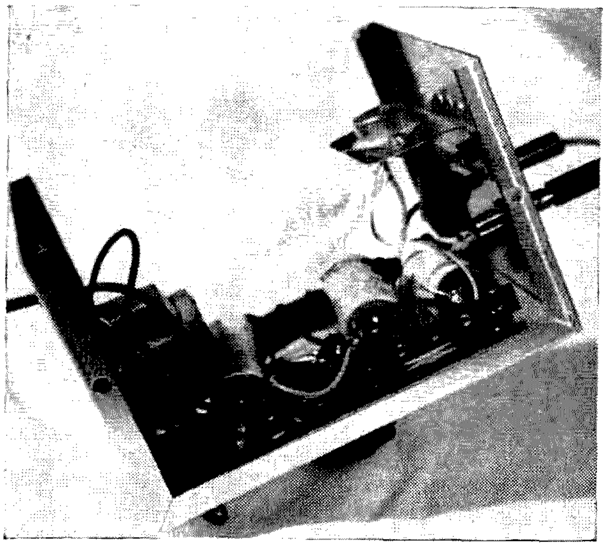


Fig. 2. Mounting the series regulator transistor.

that transistor heating is a factor at low output voltages and without a heat sink incorporated in this supply it is not advisable to run on high current for lengthy periods of time without cooling the 2N301 off. However, as stated before, this can be overcome by adding a heat sink for the 2N301 and additional bulk to the supply. In most transistor circuits the current requirements are quite low and this supply has more output than is normally required or needed.

The hookup of the circuit follows with most power supplies in that it is quite simple and the main factor is the insulation of the 2N301 shelf and plugs from the case. Placement of the components is not critical and can be made to your own pet methods. The adjustable feature is quite useful in that you can determine the voltage limits at which a piece of transistorized equipment will operate properly. I have come up with many other uses for this piece of equipment and I am sure you will too.

Those of you getting your "feet wet" on transistors will appreciate the usefulness of this supply.



Inside view of the power supply.

Martin Krey K7NZA
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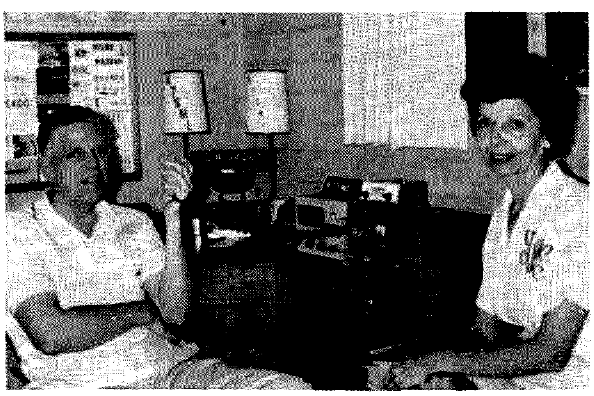
Phoenix 19, Arizona

Here's a Ham with a Heart

Charles B. Grout is a ham with a heart—and a peck of trouble. In fact, it's the trouble that has given him the time to be Mercury for other multiple sclerosis victims. Yep, that's right, K7SML is an MS patient himself, and since he knows first hand what an MS victim has to contend with in the line of handicaps, he goes out of his way to make his Phoenix ham station something of a message center for MS patients and their relatives and friends.

Ten years ago, Charles was a Denver area banker on his way up. At forty-two he was president of the Littleton National Bank of Littleton, Colorado. Life was bright and challenging. Then he got MS, and his world of business was shattered. He continued as bank president as long as doing so was wise; and then, realizing that MS is a progressively worsening illness, he gave up his high office and moved to Phoenix for its healing warmth.

That was six years ago. The mild weather didn't make Charles's illness any better, but it kept him feeling good enough to want to do something worthwhile with his time. In 1962 he decided that since he had been trained in Morse code in the Navy during World War II, he would make a stab at getting into ham radio.



Chuck Grout K7SML, answers a CQ in his shack in Phoenix while his XYL, Ida, stands by to help out on the land line. Rig is an SBE 33, which Chuck runs barefoot.

Considerably restricted in movement by then, Charles nevertheless pushed himself into his quest in his characteristic, determined way, and he soon got his Novice license. He operated code for a year, and then he passed his test for a General license and was in fine business shape to go on phone. Phoenix area hams had erected an inverted-V all-band trap antenna and installed his gear for him when he had gotten his Novice license, so all he had to do was swing over to a phone band and go to work on the mike.

Hamming quickly became a big thing in the life of Charles B. Grout, and he began spending most of his waking hours in front of his barefoot SBE 33. It wasn't long until K7SML was a common call on 15 and 20 meters, and the handle, Chuck, had replaced the name of Charles B. Grout. Chuck found the precision of hamming not unlike the exactness of banking; and he was glad, too, to find that radio could give him an opportunity to help other people.

In the year since he got his General ticket, K7SML has worked virtually every state, including Hawaii and Alaska, and he's gotten into New Zealand, Argentina, Puerto Rico, and Australia. During the year, he's also gotten acquainted with many of the 500 MS victims in the Phoenix area, and he's gotten a number of them in touch with relatives and friends both near and far—no mean accomplishment for a man who cannot walk or read a book any longer.

Typical of Chuck's service to fellow MS-ers is the phone patch he recently ran for a friend in Phoenix. The friend, Barclay Harris, whom Chuck had met through the MS Association,

had fallen and broken his hip. His elderly mother in Minneapolis, and his own son, who lives with her while attending the University of Minnesota, had become much distressed after hearing about the accident. Mr. Harris wanted to put their minds at ease, and he was able to do so with the help of K7SML. Chuck made a 20-meter contact in the Twin Cities area who patched him in to the mother in Minneapolis, and Chuck patched in Mr. Harris in Phoenix. Hearing her son's voice and his calm assurances erased the mother's anxiety, and she happily put her grandson on the phone to let him share in the family chat. Everybody felt better after that contact—including Chuck.

Chuck Grout says that without the help of his jovial XYL, Ida, he just wouldn't have a ham station at all. In fact, when the traffic gets heavy at station K7SML, Ida often mans the telephone and rigs up the phone patches while Chuck handles the microphone. Both Chuck and Ida like to recall the lighter experiences they've had on ham radio.

Chuck says the funniest phone-patching experience of all comes on 40 meters when a Colorado ham called CQ Phoenix with important traffic for his wife, who was visiting in the Valley of the Sun. Chuck took the call, and Ida got the wife on the land line. When Chuck patched husband and wife together, the wife promptly informed her mate that she had just started eating a big bowl of soup and that she could think of nothing more important than getting back to it. Then she hung up, leaving Chuck the job of saying 73 to the bewildered husband.

And so it goes for Chuck Grout, day after wonderful, challenging day. Whether the traffic is humorous or deeply serious, he will be in the shack passing more than his share of it. He says he figures there are a lot of people in the world who are worse off than he is, and he's going to help them if he gets the chance.

While Chuck enjoys helping others—and especially MS victims—to get messages passed, he has never gotten too busy to shoot a CQ up Denver way and get a contact there to patch him in with his eighty-year-old mother. "Moms have feelings, too," he says, "and, anyway, I get a big kick out of talking to mine."

Chuck Grout and his dedicated operation of K7SML must be an inspiration to many, for as one Phoenix ham was recently heard to say about him, "There's a ham with a real heart—in more ways than one."

. . . K7NZA

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Fuses

Protect your expensive equipment from overloads and burnouts. The simplest way to protect your equipment is with fuses. A fuse is a circuit protecting device that disconnects the equipment from the power source when a potentially damaging fault occurs in the unit. A fault is a moderate overload or short circuit that could cause a fire hazard or damage the equipment.

A fuse operates on a time element principle. The fuse will blow almost instantaneously for a short circuit, but blows after a definite time lag for a moderate overload. The time to blow varies inversely with the overload current.

When a short circuit or overload occurs, the fuse link vaporizes and becomes ionized, forming an arc. To interrupt the circuit, the arc must be extinguished. To extinguish the arc, a current zero must be obtained.

There is no current zero for direct current; therefore, the current must be forced to zero to extinguish the arc. There are two major ways to force the current to zero. The first method is to increase the arc resistance until the voltage drop across the arc equals the circuit voltage. The second method is to decrease the arc temperature and ionization. Arc resistance is increased by lengthening the path of the arc and by constricting the diameter of the arc. The length of the arc path is increased by the continued melting of the fuse link due to the high temperature of the arc. Arc diameter is constricted by use of fillers in the bodies of certain types of fuses. Arc temperature and ionization reduction is accomplished by enclosing the fuseable element in a protective tubing and filling the tubing with silica filler. When the element melts, the heat from the resulting arc melts the filler. The filler conducts heat away from the arc, reducing ionization and causing the arc to extinguish.

Alternating current periodically passes through zero. When the current passes through zero, the arc is extinguished. It is only necessary to see that the arc is not re-established when the ac voltage attempts to cause the current to flow again. When the ac current is near zero, it is very important to deionize the arc gap so the arc cannot be re-established. The arc will remain extinguished when the dielectric strength of the gap permanantly exceeds the voltage that tends to re-establish the current in the circuit.

W9ZZH is an electronics engineer (Wisconsin) at Industrial Controls Division of Square D. He likes to design and construct ham gear and has written a number of articles for 73.

Fuse types

There are two major styles of fuses: the plug and cartridge. The plug fuse will not be discussed in this article. Cartridge fuses are of two types. One type has knife blades and the other has ferrules. The ferrule fuses are normally used to interupt circuits up to 60 amps and the knife blade fuses are used to interupt circuits carrying 60 to 600 amps. Ferrule fuses are generally used in electronic equipment.

The three common types of fuses are the high speed, medium lag, and slow blow. High speed fuses are used where any time lag would be damaging to the equipment being protected. Ammeters and milliammeters are examples of this type of equipment. Medium lag fuses are the most widely used fuses. They are used when there are no special requirements, such as protecting equipment that requires high speed fusing or draws current surges. Time delay fuses are used to protect equipment that draws a high initial current that later drops off to a normal operating value. Motor starting current or power supply filter capacitor charging current are common examples of surges.

Quick acting and medium lag fuses have a single link that blows when overloaded. Slow blow fuses have a compound element consisting of a fusible link and a thermal cutout. The link acts on high currents due to shorts or very high overloads. The thermal cutout functions on low or moderate overloads, preventing the fuse from blowing.

Fuses also have voltage ratings. The voltage rating is the maximum voltage at which the less than the maximum voltage rating of the fuse can clear the circuit. The fuse will op-

erate satisfactorily in circuits with voltages less than the maximum voltage rating of the fuse. Underwriters' Laboratories require that fuses rated at 250 volts must be capable of interrupting 250 volt circuits that can deliver 10,000 amperes to a short circuit. This gives a great safety factor to the average application of a fuse.

Using fuses

Fuses are generally used to protect wiring or equipment. Wiring is fused to eliminate fire hazard due to heating effects of the overload current. Equipment is fused to prevent expensive damage due to shorts or overloads. **Fig. 1** lists fuse sizes to protect various insulated copper wire sizes.

The most common use of fuses in electronic equipment is to fuse the 115-volt or 230-volt power inputs to the equipment. To find the size of fuse to protect the power supply, determine the input volt-amperes (VA) to the power supply. Refer to **Fig. 2** to determine the size of fuse to use once the volt-amperes have been determined. The VA input to the power supply can be determined by measurement with a voltmeter and an ammeter and multiplying their indications to obtain volt-amperes.

The VA input can also be calculated from known circuit constants. If a transformer is used in the power supply, determine the VA input by multiplying each current being drawn from the supply in amperes by the voltage at which the current is being drawn. Include current through bleeder and voltage dividing resistors. Also include filament winding volt-amperes if the transformer is supplying filaments. After multiplying the various voltages and currents, add the products together to obtain the total volt-amperes delivered by the power supply. Neglecting transformer core losses and copper losses (assume transformer is 100% efficient), the input volt-amperes are equal to the output volt-amperes. Use this value to determine the size of fuse to be used from **Fig. 2**.

Medium lag fuses are normally used for fuses selected by **Fig. 2.** However, if large

B&S Wire Size	Fuse Rating (Amperes)
8	50
10	40
12	20 to 30
14	15
16	10

Fig. 1. Fuse size to protect wire gauges.

Power Supply Rating in Volt-Amperes	Fuse Rating For 115 Volt Operation	Fuse Rating For 230 Volt Operation
40-65	1	½
65-100	1-½	¾
100-150	2	1
150-250	3	1-½
250-350	5	2
350-450	6	3

Fig. 2. Fuse rating for various powers.

surges are encountered or cyclic fatigue is present, slow blow fuses should be used. Surges would normally be of the inductive or capactive type. Cyclic fatigue is caused by the weakening of the fuse link due to heating and cooling caused by pulses of current from vibrators or choppers. As the link heats, it expands; as it cools, it contracts. This weakens the fuse link in a fashion similar to bending a paper clip until it breaks. The thermal cutout of the slow blow fuse is a spring that takes up expansion and contraction due to heating and cooling, thereby reducing cyclic fatigue of the fuse link.

When fusing instruments, quick blow fuses should be used. The resistance of the fuse must be taken into account. To determine the size and resistance of fuses to be used in instruments, manufacturers catalogs should be consulted.

A common error made in the selection of a fuse is to select a fuse with a rating almost equal to the normal current in the circuit to be protected. Since a fuse is a heat operated device, its characteristics are similar to those of a light bulb. The more current passed through a given light bulb, the faster it will burn out. A lamp operated at three percent higher than its rated load will have its life reduced by about 30 percent. Fuse life is also governed in a similar fashion. Therefore, a fuse should always be operated at currents below its rated current to increase its life. The fuse rating should be selected to be somewhere between the normal current in the circuit to be protected and the lowest overload current that could cause damage. This gives the fuse longer life, but allows it to protect the circuit in case of overload.

Now that you understand fuses, check your equipment and see if it is fused. If it is, check that you have the proper size. If your equipment is not fused, fuse it. Better to burn up an inexpensive fuse than your expensive equipment.

. . . W9ZZH

Eugene Fleming WØHMK
328 Gunnison Ave.
Grand Junction, Colo. 81501

Confession

Sure, I know it shouldn't have been done, but sometimes a fellow has no choice. The judge hasn't decided what the punishment will be yet. Obviously, it's a new crime. No one seems to doubt that it is a crime, even though there is no law against it. The lawyer made a point of that at the trial, but then he really wasn't on my side. Maybe they will think up some new punishment to fit the crime like exile from Earth or something.

It all started one afternoon when the 15 meter cw band was just beginning to open up. There were a couple of QSO's going, but they were not the kind you want to break into. So I gave a good long CQ myself to open up the band a little. When the receiver came on, there was already a zero beat S9 signal calling.

". . . ØHMK WØHMK de MR2LK/m MR2LK/m AR"

"MR2LK MR2LK de WØHMK R Tnx fr call Ur RST 599 QTH is 328 Gunnison Ave, Grand Junction, Colorado Hndl is Gene" With my left hand I flipped the log open to the countries list. "Rig hr is SC 100 rcvr es xmtr is DX 100" No MR2 land listed. Maybe he is in one of those new African nations. "Pse QSL QTH? MR2LK de WØHMK K"

"WØHMK de MR2LK R Ur RST 579 Present QTH is approx 2300 miles above western U S in synchronous orbit of Earth Home QTH is Saklar in what u call northern hemisphere of Mars Hndl is Sobem Rig here is special built using a computer for translation, so will not describe We would like to ask a favor of U Would U consider WØHMK de MR2LK K"

"MR2LK de WØHMK R U r pulling my leg OM Better cut this false signal b4 FCC tunes u in" It had to be a local running low power to be lobbing in the kind of signal this guy had. "Have to admit it is real original gag tho QTH? MR2LK de WØHMK K"

"WØHMK de MR2LK R Earthman U R insolent Close ur eyes immediately" I did it involuntarily. Before I could think what it was all about there was a flash like that of a flashbulb and the faint smell of ozone in the air. The cw resumed. "in case u think that was a coincidence, keep them closed" I needed no urging. There was another flash and more ozone. "Can Earth technology match that, Gene Will U co-operate with us now WØHMK de MR2LK K"

If they could make a noiseless flash like those two, no telling what else they could do. I dreaded to think of making them angry. I had no ambition to end up as a puff of white smoke, or for that matter black smoke either. There was only one logical thing to do.

"MR2LK de WØHMK R OK U R convincing But what if I tell our government U R up there" This time there was no warning before the flash. Luckily, it was behind me, but it took a full minute for my eyes to recover. No one would have believed such a story anyway, but I was stalling. The foreigners waited patiently. "State your request MR2LK de WØHMK K" They'd get no satisfaction from thinking me willing.

"WØHMK de MR2LK R U will make a list of the forsythia trees in your city and report the location of each to us Do U understand WØHMK de MR2LK K"

"MR2LK de WØHMK R What is forsythia Is that ur name for that kind of tree or earth's If earth's, what language" The initial surprise and fright was beginning to wear off now and was blooming into curiosity and fantasy. "How long have you been up there Am I the only one to be counting What kind of power did

you use to get here Are ur electronics all solid state Will you be coming down soon How many are in ur crew Have you developed useful telepathy R ur intents friendly MR2LK de WØHMK K"

"WØHMK de MR2LK R Keep ur questions to yourself We do not need a lesson in linguistics, Earthman Forsythia is Anglisized form of the Latin name for an ornamental shrub of the same family as the olive tree It produces yellow bell shaped flowers in the spring before it leafs Do U understand our request WØHMK de MR2LK K"

"MR2LK de WØHMK R Yes I know the plant K"

"WØHMK de MR2LK R Count them in your city and listen for us to contact you on this freq 5 days from now U will report location of each plant K"

"MR2LK de WØHMK R It is not possible to make contact on the fifth day It will have to be the seventh K" I closed my eyes tight and waited.

"WØHMK de MR2LK R That is acceptable SK WØHMK de MR2LK/m CL"

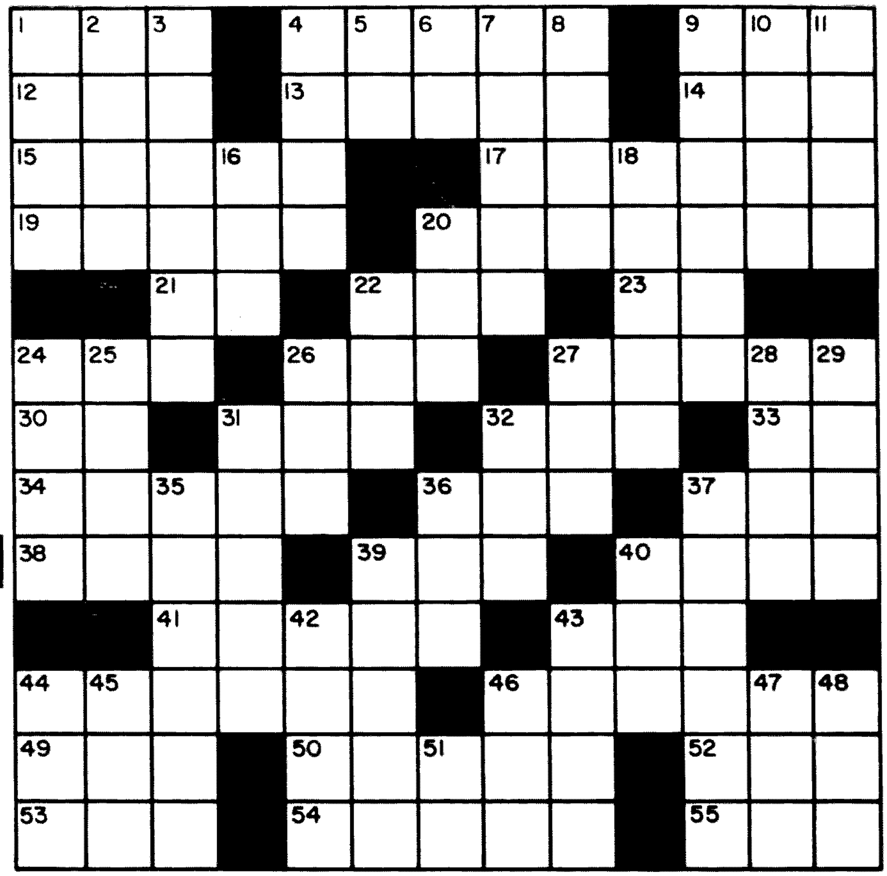
Well, the rest of the story has been in the papers, so there is no need to tell how the transmissions were taped by an SWL down the street, how the FCC monitored the report a week later, and then turned their tapes over to the FBI, or about the hearings.

You would think they would give you an award or something for being the first to make contact with extra-terrestrials, but instead I get locked up for counting bushes. But how could a guy like myself know the Army had used those bushes as a hiding place for their Martian detectors?

. . . WØHMK

Max Winter K2PIJ
2444 Barker Avenue
New York 67, New York

Crossword



Solution on page 114.

Across

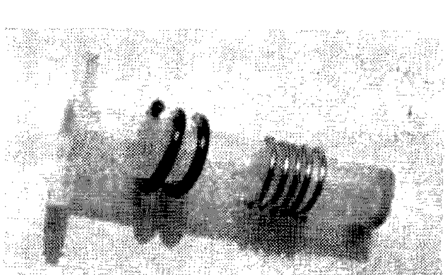
1. Amateur radio operator
2. Vents used in bass reflex speaker enclosures
9. Adjustment of a transmitter's rf amplifier stage to resonance
12. Consumed
13. Type of quartz crystal
14. Fruit drink
15. Movable plates of a variable capacitor
17. Bandwidth of a crystal
19. Type of gas sometimes used in voltage regulator tubes
20. Old-fashioned word for antennas
21. Type of circuit coupling
22. Continent (abbr.)
23. Band from 30 to 300 kc (abbr.)
24. Substance in tube indicated by a dot in diagrams
26. Type of blocking coil (abbr.)
27. Trials for a piece of equipment
30. Prefix letters for certain types of connectors
31. Type of wire insulation (abbr.)
32. Vehicle for a mobile rig
33. New England State (abbr.)
34. Antenna supports
36. Cover
37. Radial disc attached to dissipate heat
38. Girl's name
39. Vase
40. Common material used for a mast or a beam
41. Nimble
43. Unit of relative power used to express amplitude
44. Mechanism used on indexed rotary switches
46. Small octal based tube used in portable sets
49. Transformer winding (abbr.)
50. Term used to indicate that current is being taken from a source
52. Present name of RETMA
53. Transformer winding (abbr.)
54. Rescued
55. Transportation systems

Down

1. Mata - - - -
2. Weight of BC-610
3. Electrical measuring instruments
4. Component
5. Old Timer
6. Type of circuit coupling (abbr.)
7. RF section of a receiver
8. Celestial body
9. Opposite of farads
10. Matinee - - - -
11. Church seats
16. Grampus
18. Teaser
20. Stabilizer circuit in an FM tuner
22. Stabilizer circuit in an FM tuner
24. Diversion for children
25. Study of the body (abbr.)
26. Type of circuit coupling (abbr., plural)
27. Partial output point of a transformer winding
28. Open a circuit breaker
29. Trigonometric function
31. Components in a circuit having one or more vacuum tubes with a single input and output
32. Against (prefix)
35. Noise heard on a radio receiver
36. Three (Italian)
37. Device used to block certain frequencies
39. Shorter in wavelength than VHF
40. Writing implement
42. Race of people (abbr., plural)
43. Radio frequencies within definite limits
44. Displaced persons (abbr.)
45. Before
46. Near (German)
47. Dielectric for some types of variable capacitors
48. Mothers (colloq)
51. Mean (abbr.)

Hypo Coil Form

In constructing ham gear over the past few years I've often run into the problem of procuring good quality coil forms for small pieces of equipment. Here is an easy way to convert something that is readily available and easy to work with. We are all familiar with the disposable syringes used extensively today for innoculations. Well they make dandy coil forms with relatively little modification. Simply remove the plunger and the needle and trim down to an appropriate size for your need. Then wind your coil. For mounting, simply drill a small hole in each tab on the sides of the barrel and you can mount the unit on any surface. The syringe barrels can probably be prosured from any family doctor or clinic that you are familiar with. If worse comes to worse you can buy them at any local drugstore. They come in a variety of sizes and lengths. If used carefully they can be a real "shot in the arm" for any piece of gear.



. . . Stanley Scalize W4WZZ

Use your old converter on 12 volts.
S meter, TNS, and BFO, too.

Denys Fredrickson WØBMW
3923 E. Funston
Wichita, Kansas 67218

Low Voltage Gonset Super Six

This article describes my conversion of a Gonset Super Six mobile converter and other mobile accessories to use with a modern transistorized auto receiver that doesn't furnish the high B+ old receivers did.

Gonset Super Six modifications

The first task I undertook was to modify the converter for low voltage operation. The completed schematic is shown in **Fig. 1.** Many of the existing components were used; the tuning and oscillator circuits were left intact except for the tubes. A 500 pf capacitor was paralleled with the existing 100 pf rf input coupling capacitor; this really increased the signals. The AVC switch was disabled, but you may use it if desired. The wiring of the "Broadcast-High Frequency" switch on the front of the converter was modified so the whip antenna could also be used for the broadcast antenna. The 200 pf capacitor added between the switch and the whip antenna connection may be required if the auto radio trimmer will not peak up the signal. This will reduce the effect of the shunt capacitance added due to the long coax cable connected to the whip antenna. This value may not be correct for your particular installation and car radio input. The optimum value may be found by the cut and try method. A filter was added to the converter 12 volt input line by making a choke out of #16 insulted line with 20 closewound turns on a ⅜" form.

The existing oscillator tube socket in the Super Six may not have all the socket inserts to accommodate the 12EK6 tube. This can be rectified by simply removing an insert from another socket and pressing it into place. This eliminates the need for replacing the socket.

Denys is an electronics engineer for Boeing Aircraft. He's also a semi-professional magician and makes his own tricks—watch out for him at hamfests.

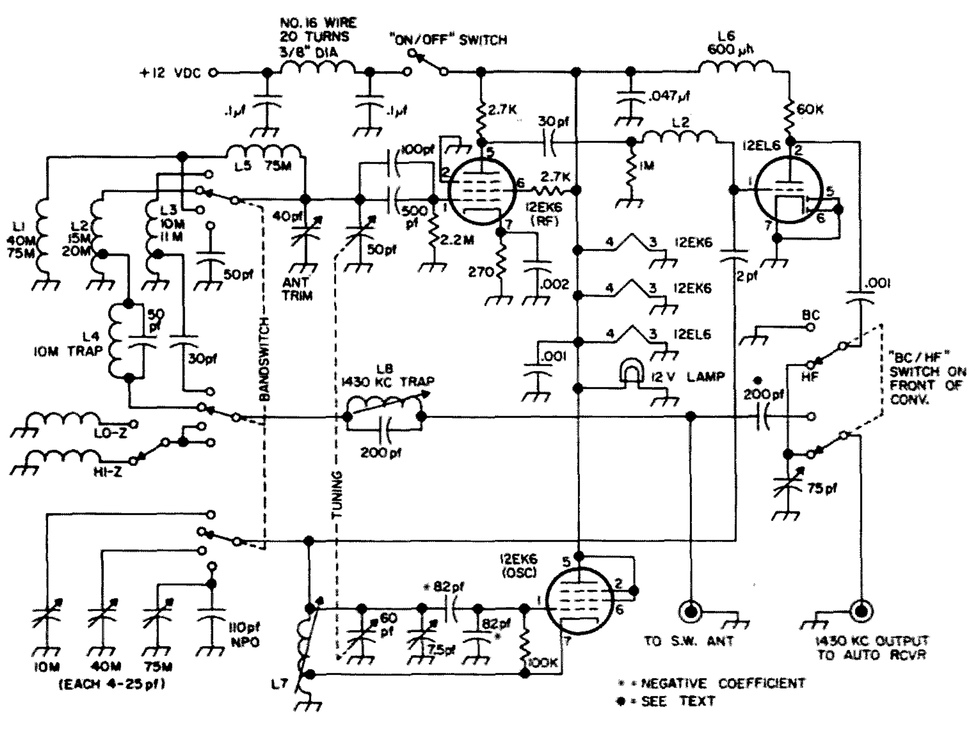
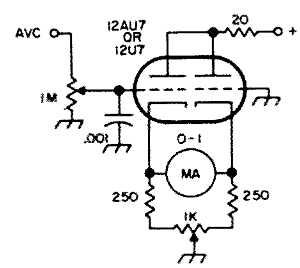


Fig. 1. Gonset Super Six modified for low voltage operation.



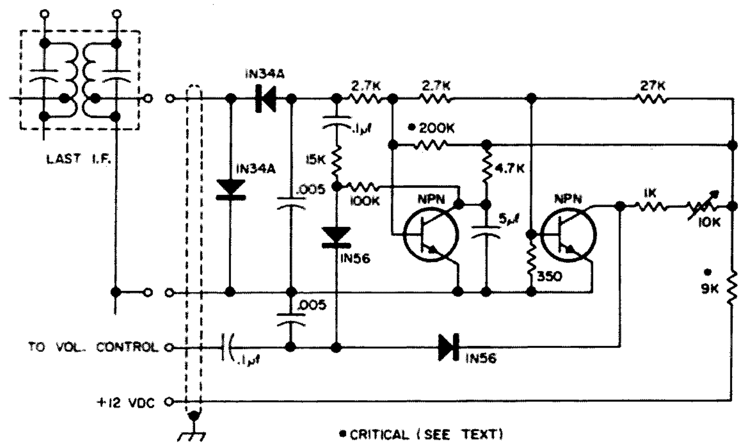


Fig. 2. S meter circuit using dual triode 12U7.

Fig. 5. Transistor TNS for transistorized receivers.

The 20 meter band must be aligned prior to aligning any other band. This is accomplished by adjusting the variable capacitor on the rear apron of the converter. The oscillator coil may have to be adjusted slightly if the capacitor doesn't quite make it. After the 20 meter band has been aligned these two must not be re-adjusted during the remainder of the alignment. Be sure the chassis is in the cabinet when alignment is being accomplished. When aligning the 10 meter band, the frequency changes considerably when the cabinet is removed to obtain access to the 10 meter padder capacitor. It will be necessary to note the frequency change when removing the cabinet and then align the 10 meter band accordingly. The 40 and 75 meter bands can be aligned and the 1430 kc output peaking capacitor can be adjusted with the converter completely assembled.

S meters

The S meter circuit shown in **Fig. 2** was used by many mobile hams. It can easily be used with low voltage tubes by replacing the 12AU7 with a 12U7 and connecting the plate leads to 12 volts through a small resistor.

Many of the new transistorized car radios don't seem to work well with the circuit in **Fig. 2,** so I tried a couple of small transistorized meter amplifiers. They are shown in **Figs. 3** and **4.** When no signal is received, the meter should read zero unless there is some current leakage. This can be minimized with silicon transistors.

Transistorized TNS

The transistorized squelch shown in **Fig. 5** is taken from the May 1961 CQ. It works very well, but to make it work properly with some transistor auto radios, the TNS ground circuit must be isolated above chassis ground due to the circuitry of some auto radios and connected to the low side of the last if transformer as shown in **Fig. 5.** The detector circuit of the auto-radio must be disconnected from the if transformer. It may be necessary to disconnect the audio input lead from the volume control also, depending upon the radio circuit. These leads must be left disconnected for proper TNS operation. For optimum operation, it may be necessary to temporarily install a 30K pot in series with the plus 12V DC lead. Adjust this 30K pot and the squelch control until full squelch control is obtained. Remove the 30K pot and measure the resistance and install a fixed resistor of the same value. You may have to file a V-notch in a resistor of lower value to bring it up to the exact resistance required. This resistor served another purpose by providing isolation between the 12-volt supply and the TNS. Prior to the insertion of this resistor, the noise was uncontrollable and unbearable. The 200K resistor may have to be varied for optimum results but is not too critical.

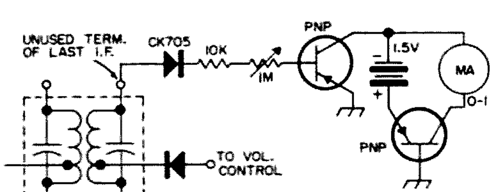


Fig. 3. Simple S meter using 1.5 volt battery.

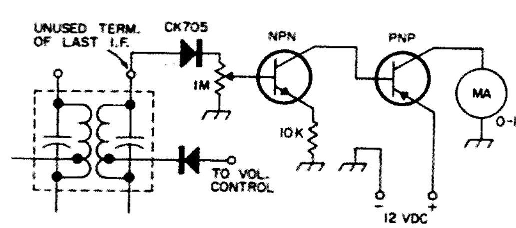


Fig. 4. S meter amplifier using auto voltage supply.

BFO-Q multiplier

Very little need be said about the transistorized Q multiplier shown in **Fig. 6.** It comes from the January 1958 QST. To use the circuit as a BFO it was found that the feedback capacitor C_1 had to be changed until oscillations were obtained. Several different PNP transistors were used and all were made to oscillate satisfactorily by changing the amount of feedback capacitance. Another word of caution is to use a 3 pf coupling capacitor between the RG-58 cable and the mixer-oscillator stage in the auto radio. This will prevent any disturbance to the radio alignment. Be sure to keep the leads as short as possible.

These modifications make the Gonset Super Six-car radio very satisfactory for mobile use. If you have any queries for me, please include a self addressed stamped envelope.

. . . WØBMW

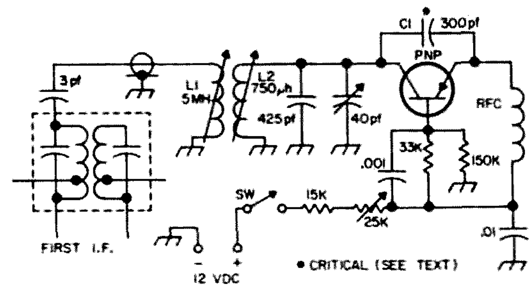


Fig. 6. 262 kc Q multiplier-BFO.

Larry Levy WA2INM/1
Marlboro College
Marlboro, Vermont

Cut-out Capacitors

I have often found when building equipment for VHF and UHF that the biggest problem encountered was the availability of adequate bypass capacitors. Often, space considerations and lead dress make it very hard to fit something in that will do a good job. At the higher VHF frequencies, ceramic disc capacitors often have too much lead inductance to properly bypass. At the UHF frequencies, it is hard to find anything that does not have too much lead inductance to properly bypass. It seemed that the answer to my problems was to construct my own capacitors, which could fit into the spaces required and still have low enough lead inductance to be an adequate bypass.

The simplest type of capacitor is two sheets of metal with some type of dielectric between them. If the capacitor is to serve a bypassing function, one of the sheets of metal could be the chassis. This will reduce lead inductance by eliminating the lead. The other sheet of metal wound up being a piece of copper foil. Dielectric was a problem, as well as mechanical mounting. I had some Teflon film, which makes an excellent dielectric, as well as having the advantage of being relatively insensitive to heat, which means that soldering will not destroy it. Mounting was solved by glueing the copper foil to the Teflon, and then glueing the Teflon to the chassis. The result of this is a copper-Teflon-chassis sandwich,* functioning as a bypass capacitor with very low inductance.

The details are simple. A sheet of copper foil is glued to a sheet of Teflon film. This combination can be cut out to shape and glued to the chassis.

I have found that contact cement will work to glue the two materials together. I am not sure how good a dielectric it is, and I am sure that better adhesives are available, but this does work and it is easily available. You coat both surfaces that are to be glued with the cement, let them dry 10 or 15 minutes, and just press together. Use caution in pressing the two surfaces together, especially with the copper foil, or the foil will not be flat, causing more inductance and less effective capacitance for a given area. It is just about impossible to separate the materials after they touch. The contact cement can take the heat of soldering for a while without unbonding, so it is easy to mount the capacitor and then solder the leads to it.

There are many possible uses for this. It can be made up in sheets and cut out to fit around a tube socket, as a B plus feed bypass, for example. It will withstand several hundred volts using thin Teflon film. About one square inch is an effective bypass at 220 mc, possibly requiring somewhat more at lower frequencies. A square can be glued to the chassis at almost any point a bypass is needed, and if part leads are kept short, there will be negligible inductance.

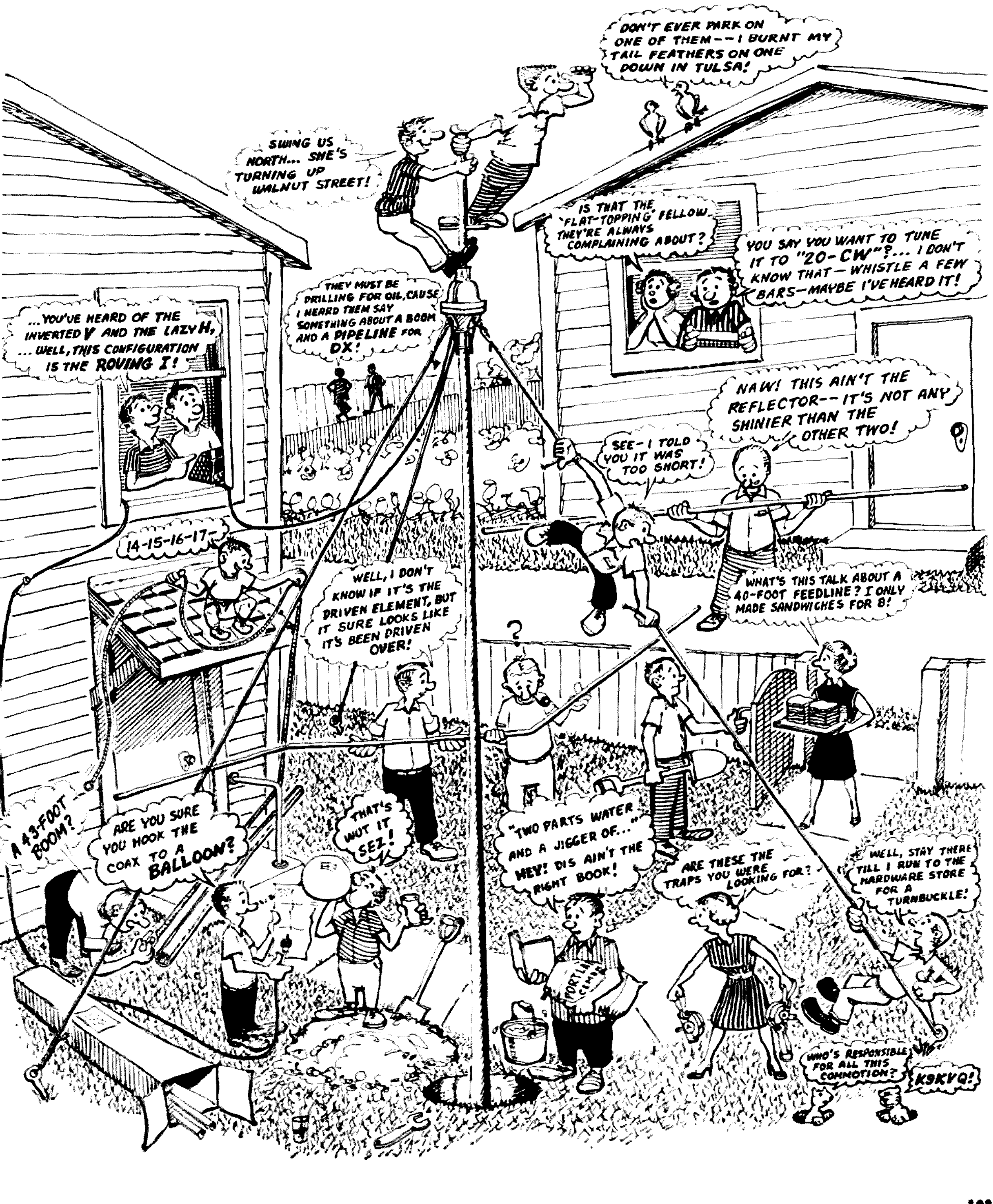
It will be worthwhile to give it a try the next time you are building VHF or UHF equipment.

. . . WA2INM/1

*An even simpler high frequency capacitor is a piece of double clad Fiberglas laminate. It's a bit harder to mount on the chassis, though. WA1CCH.

The Antenna Bee

As seen by Rodger Nordlung K9KVQ



Del Brown K9CZI
2619 Lakeshore Drive
Sheboygan, Wisconsin

Put your HX-50 on MARS

The HX-50 transmitter incorporates many features that make it a very worthwhile unit for use on the ham bands. However, like many ham band transmitters, the average owner will feel that he cannot get this unit on the MARS frequencies. In the case of the HX-50, this is not necessarily the case.

In Area 3, we had a wintertime After Dark Net that met on 3315 . . . normally upper sideband . . . and 3299 as an alternate or supplementary frequency. I had been on the VHF circuits, and decided to look over the HF as a possible additional outlet.

Checking the HX-50, and its passband filter information, I found the following to be the possible coverage: 3.2 to 4.2 mc; 6.9 to 7.9 mc; 13.8 to 14.8 mc; 20.8 to 21.8 mc; and 27.0 to 31.0 mc. As this included the 3315 channel, I calculated the required crystal frequency and ordered one for upper sideband. The internal vfo is switched in frequency when changing sideband on the normal hambands, and, of course, this would mean a need for two crystals to cover other frequencies with both upper and lower sideband.

The crystal was close, but the actual frequency was reached only by readjustment of the heterodyne oscillator trimer C-158. In view of this problem, I decided that another crystal for the other sideband would be more of a problem than I wanted. This was brought to the fore when they switched from upper to lower sideband on two occasions to avoid QRM.

I dug out an old BC-458 which had been around for years and lashed it up to feed into the external vfo input. I removed one of the 1625's and lowered the plate, screen, and oscillator voltages to just one . . . . about 150 volts. Then, removed the antenna coil, and adjusted the link for the 3 volts into the HX-50 . . . . using the RF probe on the VTVM. Tried it on 3315, and it worked. A 3 plus kc adjustment put it on lower sideband. Now they could switch sidebands and I could follow!!

About this time, we were having a Technical Net on 4580 kc. Hammerlund had written that the HX-50 wouldn't go up there. This was while I was thinking in terms of crystals. One Sunday morning, I decided to try to load up on that frequency . . . and it worked. Since then, I've had the HX-50 on 4450, 4580, 3315, 3299, 7305, and all without trouble. The output seems to vary, but the signals have been Q5 with wonderfully satisfying results.

No modifications were made to the HX-50. I merely added the external vfo, and using a Johnson Matchbox with a "Drooping Doublet" antenna, no antenna changes have been necessary either.

In view of the obvious variation in the crystal frequency of the first heterodyne oscillator in the HX-50, I would suggest the use of an external vfo rather than the crystals. Besides, the VFO can keep pace with the eternal changes of the MARS (at least the Air Force Mars) program in the matter of frequency.

I normally use this little rig barefoot, and have gotten excellent reports on all these frequencies. It would seem this is the easiest way to get an existing transmitter on the MARS circuits.

The BC-458 is ideal for the external vfo also. The internal vfo has a range of 5.975 to 6.525 mc. and with the 458 range of 5.3 to 7.0 mc, you can see that the range of coverage will be adequate for most excursions. Also, the range of the vfo is constant with the HX-50 . . . . no doubling or sideband reversals are a part of its operation, when going from band to band. This means that FSK when built into the vfo requires no reversing switch.

Hammarlund has a modification for FSK using the internal vfo that is a wonderfully simple and cheap conversion using the existing Varicap that moves the vfo when switching sidebands. A schematic for this is available from Hammarlund.

If your use of the HX-50 is as successful as mine, I am sure you will agree that the flexibility of this rig is a wonderful feature.

. . . K9CZI

Armed Forces Day Tests

Saturday, May 21, is this year's Armed Forces Day, and an opportunity for hams to work military stations for special QSL's, or copy CW or RTTY messages for certificates from the Secretary of Defense. The first part of the tests will be military to ham communication from 2114GMT to 2202GMT. Military stations WAR, AIR, and NSS in Washington and NPG in San Francisco will be on frequencies near the ham bands to contact hams in the adjacent bands: **CW:** 4001.5, 4020, 6992.5, 7325, 14405 (WAR); 3269, 4015, 6970, 7301, 13992 (NSS); 3397.5, 6997.5, 13995, 49.98, 143.95 (AIR); 4005, 4016.5, 7375, 13975.5, 14385 (NPG).
Phone: 4040, 14385, 143.82 (NSS); 4025, 7305, 14397, 49.98, 143.95 (AIR); 4013.5, 7301.5, 13975.5, 49.692, 143.7, 148.41 (NPG). **RTTY:** 4012.5, 7380, 14480, 143.82 (NSS); 3347, 7315 (AIR); 4001.5, 7332, 143.7. VHF is AFSK, of course.

The NSS frequency of 143.82 will be for RTTY and AM from a plane flying from Washington to Hartford. Call is NSSAM.

The CW receiving contest at 25 wpm will be broadcast at 2203 GMT from Washington on 3269, 3347, 3397.5, 4015, 6992.5, 7301, 7315, 13992 and 14405, and from San Francisco on 4001.5, 4016.5, 6997.5 and 7301.5.

The RTTY receiving contest at 60 wpm will be at 220335 GMT from Washington on 3347, 4012.5, 6992.5, 7315, 7380, 14405, 14480; San Francisco on 4001.5, 4580, 6997.5, and 7332; Texas on 4025, and Illinois on 4590 and 7540.

All transcriptions should be submitted as received with time, frequency, call sign and address of individual submitting the entry on the page containing the text, to Armed Forces Day Contest, Room 5B960, Pentagon, Washington, D.C. by May 31.

Checking Frequencies

Quite often it becomes necessary to determine the resonant frequency of a well shielded coil or one that is in a place not readily accessible. In order to grid dip a coil of this sort, some means must be found to get the coil coupled to the grid dipper.

By wrapping a wire around one pin of the grid dipper and inserting the other end of the wire close to the coil to be measured, a dip can be observed. It may be rather small, so care must be used.

A short wire connected to the coil in question and the other end inserted in the coil of the grid dipper will give the same result.

. . . L. A. Stapp WØPHY

Editor's Note: The very popular "Kleiner Keyer" was described in 73 issue of September, 1965. Many hams who have built it will appreciate these improvements which our author has developed since moving to the sunny south.

E. L. Klein W4BRS
6814 Criner Road, S. E.
Huntsville, Alabama

Improving der Kleiner Keyer

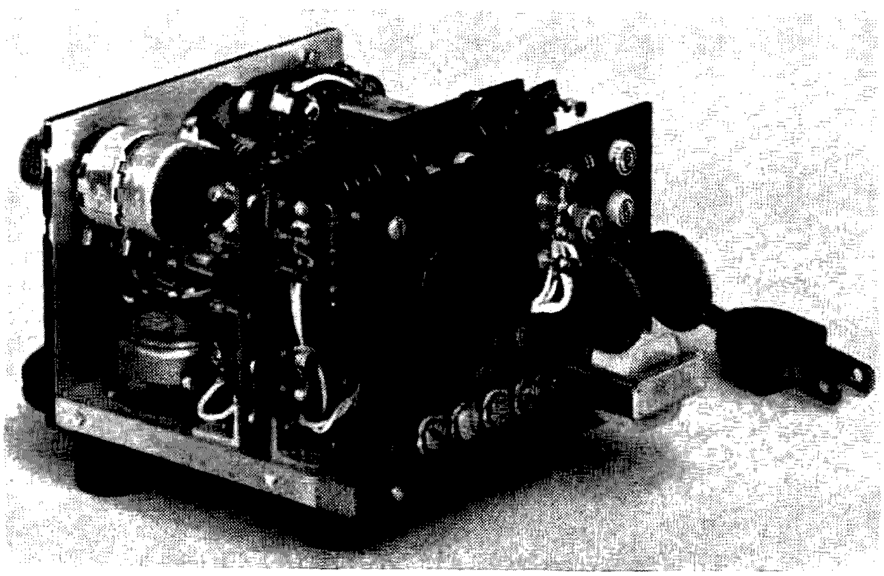
Normally judging from the correspondence received on der Kleiner Keyer, a great number of hams have found it to be a worthwhile home construction project. In the meantime, a number of improvements have been made on the original model and are described in this article. Most noteworthy of these improvements is the keying monitor which is shown in the photograph and accompanying schematic diagram.

Keying monitor

An astable multivibrator was used as the audio oscillator because it draws less current than many other oscillator circuits and is relatively free of tone changes when voltage changes occur in the power supply. As in the rest of the keyer, PNP transistors are used. Their characteristics are not critical and surplus transistors such as those advertised in the back of this magazine will work very well for Q 8, 9 and 10.

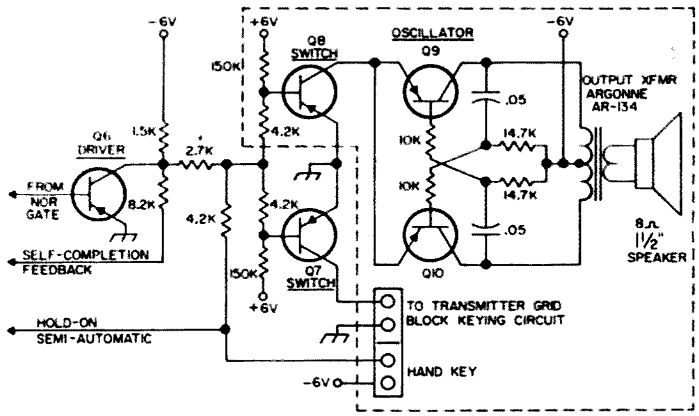
Gene has held a number of calls: W7HNT, W3MCM, W4UHN, J2BAC, JA2AP, WA2QYD, and WB2PKE. He's an engineer (U. of Washington), a private pilot, likes to build and has written many articles.

The reader will observe that an isolating circuit comprised of Q 8 and its bias resistors is used. This circuit "switches" the audio oscillator off and on as well as provides further isolation of the oscillator from the grid-block keying transistor, Q 7. Several other minor circuit changes were also made to provide hand-keying capabilities and improved semiautomatic operation. The builder will find it desirable to experiment with various values for the 2.7K resistor (*) to obtain equal dot and dash tones when operating in the semiautomatic mode.



Rear view of the keyer with the cover removed. The new component board is shown mounted from the keyer base. Audio oscillator, speaker and terminal board are accommodated by this third phenolic component board.

Fig. 1. Schematic of the monitor oscillator The portion of the Kleiner Keyer circuit within dotted line is mounted on new circuit board. Notice component changes in circuit for Q6 and Q7. Resistor (*) value to be selected at assembly; see text.



Construction

A third 2½ x 4 inch phenolic board is added to accommodate the monitor oscillator and loudspeaker. This 1/16 inch board is secured to the rear of the original base with two #4-40 screws. A ¼ x ⅜ x 4 inch spacer holds the new board out so that the 1½ inch loudspeaker will not interfere with components on the original rear board. A new cover which is 1⅛ inches longer in the front-to-back dimension completes the mechanical construction of the newly added keying monitor.

Those elusive 5.8K resistors

As many readers concluded, the dual 15K potentiometer is non-standard and, therefore, must be replaced with another value for the speed control in the free-running multivibrator. One solution which provides a two-fold advantage is to use a dual 10K potentiometer. First, a standard control is provided. Secondly, the small amount of fixed resistance which is placed in series with each potentiometer prevents the maximum speed from exceeding 50 WPM. Hence, the elusive 5.8K, ½ watt resistors which appeared in the photographs, now have a logical place in the schematic diagram.

Power supply corrections

The two 150K filter resistors in the power supply alas were wrongly labeled as 150K which is about 1,000 times their proper value. Two 150 ohm, ½ watt resistors should be used in this application.

Due to the very small load on the 6 volt supply, we find that the +6 is more nearly +9, especially when generous filter capacitors are used (peak voltage = 1.4 times RMS). A 750 ohm, ½ watt bleeder resistor across the plus supply will tame this voltage and provide more realistic biasing of the PNP transistors as well.

Mechanism contacts

One of the better insulators known to electro-chemists is aluminum oxide. And that's just what we have on the paddle contacts in a very short period of operation. Although brass screws may be used for the adjustable contacts, it is still desirable to install some form of better contact material on or in the paddles themselves.

One very successful method is to use a small piece of silver solder as a rivet and "peen" it into 1/32 inch holes which have been drilled in line with the adjustable paddle contacts. After the silver has been hammered snugly into position so that it tightly fills the drilled hole, it should be smoothed off with a very fine file or emery cloth.

Improvement of the hinge joints

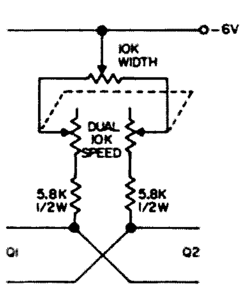
In order to provide better electrical connections through the hinge joints, a spring was added to contact the ends of the hinge rods. The spring was made of spring brass and held in place by the last two screws of the keyer mechanism.

The contacts were cut from a piece of 1⅛ x ¼ inch spring brass. Two #27 holes were drilled and 1/32 inch slits were sawed in a "T" pattern, as shown. Try not to distort the spring while fabricating it, in order to keep the contact snug on the hinge rod ends.

Once these modifications are made to your Kleiner Keyer, you will find greatly improved reliability and pleasure in its operation as we have here at W4BRS.

. . . W4BRS

Fig. 2. Wiring changes in the free-running multivibrator. Two 5.8 K resistors are added and 10 K replaces 15 K for dual potentiometer speed control.



Anthony Curtis K3RXK
East Church Street
Centre Hall, Penna. 16828

Fewer Tears, More Contacts from Within

Make your own Joystick.

There are thousands of fellows across this country in the same predicament as I, living in a home of maximum inner space and minimum outer space. Ever pound your head against the walls because your Super-Tri-Blex transceiver just doesn't cut through the soup to be heard by the stations you hear? A lot of experts on the subject of getting out will tell you to look to your antenna system first in such cases.

You say you have looked? You know that's where your difficulties lie? Well, maybe I can wipe away a few frowns. Over the last dozen years I have lived in four different locations, none of which permitted even a mediocre, outdoor antenna. Through those years, I have refined some systems for apartment-type, limited space antennas.

Most of my operating difficulties have been associated with the lower ham frequencies where antenna lengths are longest. Compacting the radiating system can be nothing but detrimental to a projected signal, yet this is the only answer for many hams such as myself who want very much to operate, even at lousy efficiencies.

Many magazine articles have described the hidden wire tricks, the attic beams, the floorboard rhombics, and the like. I would like to suggest an idea brought on by a product relatively new on the home decorating market. It doesn't appear to damage the male self-image too heavily these days for the ham-husband to allow the XYL the indoor antenna prerequisite of making it 1) as unnoticable as possible and 2) the noticeable parts as decor-matching as possible.

Tony also holds W8TIZ. He's a full time student at the Pennsylvania State University Journalism School and works as a DJ at WMAJ.

Pole lamps have sprung into vast popularity across the land and many specialty stores carry complete, un-lamped poles and/or all the various pieces which go together to make up whole poles. These poles can vary in length from 6 to 10 feet under usual conditions and possibly shorter, or longer, if you find a store selling shorter and longer extension tubing. The poles are long pieces of tubing which have spring-loaded stakes in each end. These are wedged against ceiling and floor, in a vertical configuration. Or, they may be wedged between wall and wall in a horizontal line. Of course, the tips of the stakes are rubber covered to prevent damage to wall, ceiling, or rug.

Poles come in many finishes of plated metal, paint, and sometimes wood. They can be put together as spartanly as you like, or as luxuriously as the eye of the XYL requires. If the indoor antenna would be entirely hidden, the poles could be of simple chrome plated metal. If the wife will see parts of the antenna, and if the antenna will serve a dual purpose as discussed later, then make it up to match the decor of the home area in which it will be located.

The average pole, bought whole, will be about 7 ft long which matches the height of ceiling in many apartments today. Sections can be purchased and inserted which are shorter or longer to make your vertical antenna meet your requirements. If you are going horizontal, you may wish to add long sections to lengthen

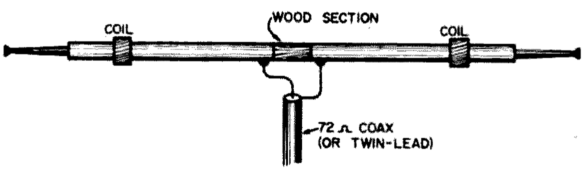


Fig. 1. Coil loaded dipole antenna.

the antenna out to 12 or 15 ft or more. In such case, check for the possible need of center support as the pole weight increases.

I have used the system in three different configurations shown in **Figs. 1, 2** and **3. Fig. 1** is quite effective when you have a long pole pushing against two walls. It is also the more complicated to build with the three "breaks" in the continuity of the pole: the center dipole insulator, the two loading coils out along each arm of the dipole.

The center insulator is usually a wooden section made by the pole manufacturers, for beauty, to replace one metal section of the pole. This will work out fine as a center, dipole insulator. The two coil inserts must be wound individually to match the specific band requirements with the size of your pole. I have used standard practices for making coils for loaded dipoles.

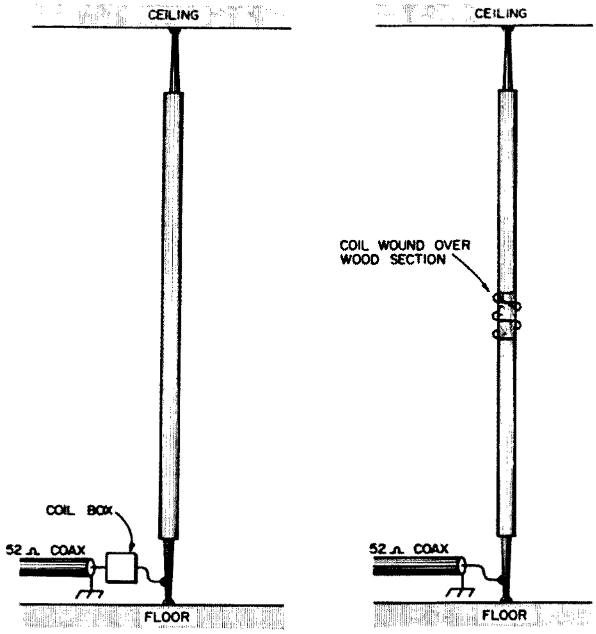
Fig. 2 is a common quarter wave vertical with base loading. I have found it convenient to build the loading coil (s) in a small, nice looking, *wooden* cigar box placed on the floor at the foot of the vertical. In my set-up, I feed the coils and antenna with 52 ohm coax, grounding the shielded side of the cable to a water pipe some ten inches away. This pipe happens to be part of a room-circling, hot water system.

These antennas will work on all bands for which they are cut; I use mine regularly on 3.5 mc, 7.2 mc, and 14 mc. Remember that these are highly compressed radiators and the higher the frequencies the better the efficiencies involved as the pole lengths reach closer to actual quarter wave and half wave figures. For this reason, I have always had better luck in getting out on 20 than 75 meters. I use, and mention, these frequencies as these are the bands covered by my NCX-3. Of course, those persons operating on 15 and 10 with this type of antenna would be better off as these frequencies approach even closer to pole length in terms of quarter and half waves.

Fig. 3 is a variation of the idea presented in **Fig. 2.** Familiar to mobile operators, this is the center loaded vertical. The 52 ohm coax feeds the base of the vertical with the cable grounded to the nearest ground point.

In this antenna, I have used again a wooden, manufactured piece made to replace a metal section of the pole. In this case an appropriate coil may be wound right on this wooden form, and connected properly to both halves of the vertical pole antenna.

Fig. 2 is the easiest to construct and is, therefore, my favorite. In a wooden-sided house where I previously held residence, I placed a



Right, Fig. 2. Base loaded vertical pole antenna.
Left, Fig. 3. Center loaded vertical pole antenna.

7 ft pole in a closet near the front door. This small area was built at an outside corner of the building and the walls appeared to be completely invisible to my outgoing waves. I managed to pick up WAS along with contacts in Europe, South America, and New Zealand with this system. No reason for me to worry over the system after that!

Here are some of the decor ideas I mentioned earlier:

The pole may be used horizontally, between two walls, and the XYL can hang drapes of non-conducting material on it for one of the full-wall drape effects which are so popular today. The drapes, while faking a picture window area or whatever these feminine tricks are meant to do, will also cover your coax as it runs to the center feed point of the dipole.

Poles or their sections can be purchased with small holes drilled in for large, round, towel-hanging rings. One might locate a corner of one's bath for a pole and hand non-conducting towels from the rings. High fashion! The coax could be concealed from the pole base into the next room for your operating area.

A neighbor suggested an even more "far out" idea. In a vertical set-up, place a horizontal arm out from the pole at the five foot level. From this arm, suspend the wife's canary in its gilded cage. This would look great, hiding the pole's real purpose. Sorry, no tests have been run to determine the physio-psychological ramifications of single-side-band operation on the canary.

. . . K3RXK

John Burke WA8BJK
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For Those Who Have Given Up Code

Since the advent of Amateur Radio, many people have at one time or another tried to become Amateurs only to balk when the first requisite could not be met. Even those Amateurs who have successfully passed their code test suffered a time when they decided that it was impossible to absorb this "nonsense" and approached a point that would prevent them from going further without the help of pure tenaciousness, or some gimmick. I discovered such a gimmick that helped me, and if there was ever anyone who needed help it was me.

I was convinced for a long time that the code requirement should be abolished, and any person in his right mind that operated in this mode was a nut. Why drive a horse and buggy when cars were so cheap? You can say more verbally and much more effectively using the mode that we are all better suited for. However in the end I became an addict to CW and it is hard to break away.

After struggling along for months, and long after my Novice license had expired, it was easy to see that my code speed was never going to exceed ten words a minute. So I decided that something was going to be done. I read some books on the subject and made a list of the things that I had done wrong. My first glaring error was in memorizing the code as dots and dashes. For those who have made this mistake, all is not lost. You can still do it. It was only after many headaches and frustrating repetitions with paper and pencil that I realized what I was doing wrong. The second mistake was scribbling, or trying to get the character on paper before it was received. This is a common mistake and its only natural to want to record the letter as fast as possible in order to be ready for the next. Both mistakes are unnecessary and most important to overcome before any progress can be made.

The third mistake was trying to copy the myriad of fists and bad signals on the air. Fast and slow, good and bad, clean and dirty, it made no difference. I tried to wade through these and make some sense of them, only to become more confused and disgusted. This was easily rectified by turning off the receiver.

I obtained a tape recorder and a good tape with code signals and went to work. It immediately became apparent that I was getting nowhere. The first plateau to get over was to be able to recognize the characters instantly and without error. I played the tape as slow as it would go and wrote the text on a sheet of paper. After several runs I finally had it all down. After setting the tape at its normal speed and replaying what I had all ready copied, I traced over the letters while listening to the tape at 13 words per minute. I was stupified at the phenomenal results! There was no need to hurry. There was time for me to make large block letters with plenty of time in between to rest and look around the room. It was tried at 15, 18, 20 words a minute with no strain on the pencil. I used this technique for a number of days, and soon discovered that dahdahdidah was no longer two dashes a dot and a dash. My mind did not have to mentally associate dots and dashes with what I was hearing. I was actually receiving code, and what's more I was putting it on paper. My speed increased in a short two weeks from a slow ten words to well over the required thirteen. In listening to on the air code practice from W1AW I was able to get the 13 and 15 words per minute almost perfect. Subsequent practice increased my speed to 20 words a minute for which I received the Proficiency Award for both 15 and 20. After my General ticket was received I managed to go on to speeds well over 30 WPM.

Please bear in mind that my experience with the code was a common one. How it was overcome was not, but the method is unique and worth a try by those who have had bad advice, and other stumbling blocks. Listen to W1AW code practice sessions and other Amateur stations giving this service. One such station that I can heartily recommend is W4RUR who conducts code practice twice a week on 40 meters. I listened to both and was able to pass my General code test letter perfect with their help.

For those who finally get to the point where

they are ready for the examination, here is a tip or two that helped get me over the hump. The evening before the test or the same day if possible, listen to a machine tape or record at exactly 13 words per minute. No other speed will do. Put it on paper. You should get it perfect. But don't be too disappointed if you don't. I'm convinced that someone very carefully chose 13 words a minute for the FCC test. It's neither slow nor fast. For me it's still difficult to copy. After listening to and copying high speed and then dropping back to slow speed, you will find yourself anticipating what is coming and have it on paper before you know what happened. This can mess you up on a test and it is hard to overcome. For this reason listen to the test speed, regardless of how fast you are able to copy, just before the test so you can gear yourself mentally for what is to come. Ten or fifteen minutes should be enough. Send yourself code mentally on the way to the examining room—at 13 words. Get this rhythm in your mind. In taking the test don't make the mistake of trying to count the characters mentally for a minute or two and trying to correct any errors and skipping the rest of the test. It simply won't work. If you make an error forget it and continue, and I mean forget it. The time spent in worrying about it, and trying to correct it will distract you and you will continue to make errors right to the end of your failed test.

If you are a Novice or Technician, let me caution you about the delusion that on the air practice will get you anywhere. It will only take the time that could be used for studying the theory. On the air practice will only slow you down and add to the QRM all ready there. Believe me I should know. As a Technician I tried for weeks to stir up some activity on six meters for practice. True, some would accommodate me and with one or two exceptions all comers set me back considerably.

When you have become an addict to the code and the CW mode of operation you will find Amateur Radio has a new meaning. As an Engineer for a large Aircraft Company my job is very demanding and is not without a great deal of pressure from time to time. Occasionally I have seated myself at the operating table, my mind wandering and thinking everything but relaxing. And then hearing a nice cheery CQ at a comfortable 18 to 20 words a minute, and with a fine fist at the other end, usually lends itself to an hour of rag chewing that absolutely cannot be beat for letting your tensions slowly drain out your system. CW is beautiful when sent right, and whenever I hear an operator with a FB fist who is aching for a rag chew I experience a thrill that makes any effort, any expense or inconvenience well worth while.

One final word. If you have prepared yourself properly for the FCC examination, you will know immediately if you passed without anyone telling you. If you passed the code, you are on your way to completing a good day, and you will have that good feeling that thousands of other Amateurs have had and know that you finally "belong."

. . . WA8BJX

(*Continued from page 2*)
black box. PE wonders if something new has been discovered or whether there is a hoax involved somehow. Interesting. The story reminded me of a little experiment I pulled off 22 years ago. Good heavens, how time flies! This was back during the war and QST was marking time for us with little communication projects using light, ground, etc. The ground bit interested me particularly and I decided to give it a try.

For those of you who might not have read all the stuff from those olden years, it seems that if you poke a couple stakes in the ground and feed audio into them, the signal will be detectable for some distance to an audio amplifier hooked onto two other electrodes.

Since I didn't have any ground around me anywhere I decided to use what I did have: water. We were cruising off the coast of Okinawa at the time, surfacing at night to recharge our batteries and looking for an unwary Jap ship to sink. Unfortunately most of the Jap ships we sighted were sub chasers and we had to be pretty careful.

There was about 2/10 of an ohm resistance between the APR-1 forward and aft dipoles, so I hooked the low impedance tap of a small audio amplifier to them, turned up the gain and said, "Hello." About ten seconds later came the call . . . "Green to the conning tower." I rushed up to find the underwater sound man all excited. It seems that someone had just spoken very clearly through his sound gear and said hello. Hmmm . . . wonder who that could have been. About this time the fellow arrived from the forward torpedo room . . . he had heard the same thing on his JT sound gear. By George! They both reported it was very loud . . . very, very loud.

I listened to the reports from the two sound men and thought for a moment . . . yes, I could fix that right up . . . nothing to worry about, sir. And I did fix it . . . they never had any more problem with strange voices on the sound gear.

I understand that the Icefish, some miles away, heard the same strange voice. How about that?

Every now and then I've wondered why this system wasn't used for underwater communications, but I supposed that there probably were reasons. Obviously it was something that many people had researched thoroughly years ago . . . or was it?

Mensa

Every now and then I get a letter from an amateur who is also a member of Mensa. Fine. I'd like to see more of you join Mensa. I think it would be very good if every amateur who can make it would join. If you've got smart brains, prove it. Write to Box 86, Gravesend Station, Brooklyn 23, New York for details. Mensa, a club for people in the top 2% IQ, is quite active in the larger cities . . . and only a small percentage are in it to show off how smart they are.

The New President

At the Flatbush Radio Club the other evening I was asked what changes I would make if I were made president of the League. Interesting thought.

Number one would be a long facts-of-life session for the Directors to acquaint them with the real situation that amateur radio is in these days. From there we would take the steps necessary to set up a public relations department of the League which would gather information of all of the valuable things that are being done by amateurs and see to it that these stories are released to the newspapers, presented in feature magazine articles and given world wide distribution. This could have a profound effect in getting more people interested in our hobby and give it a tremendous boost in official circles all over the world.

Next I would open that controversial Washington office and arrange it so that the League could for the first time have some influence in Congress what happens to our hobby. I would make it so that the League could honestly say that they represented amateur radio rather than just exploiting it.

Then, as president of the League, I would go to Washington and try my damndest to get an amateur radio section of the Peace Corps established to send small teams of amateurs to the newer countries to set up amateur club stations and train locals in the basics of radio and communications. If we can get amateur radio really started in these countries we will have given them a tremendous boost for they will then have experienced men to draw upon for commercial and government communications and electronics work. Without amateur radio there just is no one to even start with in these fields.

Then I would visit the member societies of the IARU and find out what can be done to get amateur radio ready for the next ITU conference. I'd get the ARRL Directors to authorize the funds to set up a small office in Geneva with one full time amateur in charge to provide communications for the Region I IARU, including a monthly bulletin

to all concerned.

All this would cost money, no doubt about it. And even though The League has over a half million dollars sitting around in cash and securities which it is not using in any way for our advantage, I believe that the additional expenses can easily come out of increased income.

All the above, and more, could easily be done for under $80,000 per year. This amounts to just $1 per ARRL member more than is now being collected. A small increase in the advertising rates of QST would achieve the same result and their rates would still be about one third to one fourth those of any comparable publication in any other similar field. No, there are many ways to easily finance the job that must be done. All we lack at present is the will to do it. This is why it is so extremely important that all of you support the Institute.

Suggestion

It might be worth while if the ARRL Directors devoted a little of the time of their short yearly meeting to a discussion of ways for the League to re-establish confidence in amateur radio among the amateurs.

The repercussions of the Incentive Licensing hassle should be apparent to everyone by now. I told you that they looked like they would be serious and they certainly have proven to be that.

The immediate response was turmoil in the amateur ranks. This was followed by an intense depression in our field. Sales of new gear fell off and the prices of used gear dropped badly. This had the effect of driving dozens of ham distributors to more rewarding lines of business such as CB. It seriously hurt many of our ham manufacturers and seems to have caused many of them to lose faith in the ham market. We now see several of our largest and oldest ham manufacturers wavering on the edge of dropping out of the ham business completely.

It is possible that confidence can be regained in ham radio if the League acts immediately to remove the Sword of Damocles that is hanging over us all by putting all of their pressure to work on getting the FCC to forget Docket 15928 and Incentive Licensing.

Ham radio and the large firms that have done so much to support and encourage the hobby have been the victim of the ill considered actions of a couple of people at headquarters. It is just possible that this tide can be turned if the Board acts immediately.

. . . Wayne

Henry Cross W1OOP

Permanent Cure for the NC-300 Filament Regulator

The oscillator heater in the NC-300 is fed from a 12 volt tap on the power transformer through an Amperite current regulator. These work very well but seem prone to quit at critical times. A 6V6 will be found in most 300's instead, as it will make the beast run, even if it won't regulate. The circuit shown was installed in a 300 belonging to W2NSD. C1 is at least 1000 µf, at least 12 working volts. D1 was a shorted 2N301—or a good one . . . power transistors are fine low voltage diodes. D2 is a 1N1602 (International) or other 6.2 volt ten watt zener diode. If the stud goes to the anode in what you can get, turn the other diode and electrolytic around—mica washers are too fussy. For a 6AH6 R1 came out about 8 ohms 10 watts (10 in parallel with 40). The action would be better with about 2500 µf and 8 ohms.

. . . W1OOP

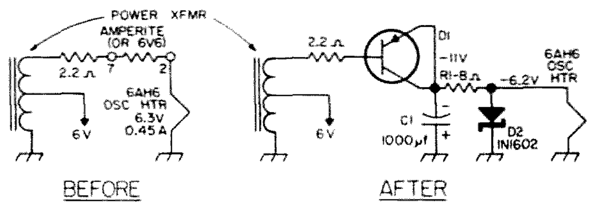


Fig. 1. A permanent cure for the NC-300 filament regulator's troubles.

Solution to the Crossword Puzzle on page 98

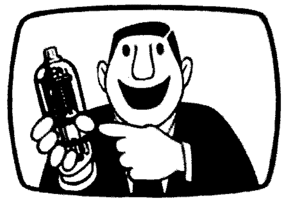
H	A	M	■	P	O	R	T	S	■	D	I	P
A	T	E	■	A	T	C	U	T	■	A	D	E
R	O	T	O	R	■	■	N	A	R	R	O	W
I	N	E	R	T	■	A	E	R	I	A	L	S
■	■	R	C	■	A	F	R	■	L	F	■	■
G	A	S	■	R	F	C	■	T	E	S	T	S
A	N	■	S	C	C	■	C	A	R	■	R	I
M	A	S	T	S	■	T	O	P	■	F	I	N
E	T	T	A	■	U	R	N	■	P	I	P	E
■	■	A	G	I	L	E	■	B	E	L	■	■
D	E	T	E	N	T	■	B	A	N	T	A	M
P	R	I	■	D	R	A	I	N	■	E	I	A
S	E	C	■	S	A	V	E	D	■	R	R	S

(Continued from page 4)

Well, we're all being jarred more and more these days. Two names for frequency units have been causing more and more problems (though I can't believe they're that serious) in international science and engineering as these fields tend to be less and less nationalistic and more international. An international conference a few years ago decided that it would be better to use hertz, and the USA National Bureau of Standards and Institute of Electrical and Electronics Engineers have accepted this ruling, as have most of the engineering level publications in this country. Now the hobby and technician magazines are starting to, too. Massive resistance to apparently inevitable social changes seems to have had little worthwhile effect recently, and I suppose that the same can be said for resistance to hertz.

Hz, kHz and MHz for cps, kc and mc will undoubtedly offend your eyes as much as ours at first, so we're going to switch to them slowly to get you accustomed to them. If Hz annoys you, think of how I'm going to enjoy changing all of those cycles, kc, and mc to Hz, kHz, and MHz in all of the manuscripts we publish.

. . . Paul



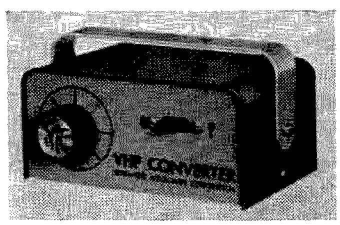
NEW PRODUCTS

Denson's 20th Anniversary

Al Denson has just brought out a fat, 96 page twentieth anniversary catalog full of TV, ATV, test equipment, ham gear, surplus, TV camera kits, etc., etc. You'll spend hours looking at this catalog, drooling over the contents every minute. It's also got lots of schematics, conversions, information about equipment and other interesting data. If you're a builder, you've got to get this one. Write to Al Denson, Rockville, Conn., and ask for catalog 965-S1.

Lafayette Spring Catalog

If you haven't gotten Lafayette's new Spring catalog, number 663, be sure to write them and ask for a copy. Address is 111 Jericho Turnpike, Syosset, L. I., N. Y. 11791.



Scientific Associates VHF Converters

The new Scientific Associates solid-state converters come in tunable and fixed frequency models for HF and VHF reception. An interesting feature is built-in squelch that can easily be connected to the receiver the converters are used with. They come in many models at prices from $24 to $35 and you can get details from S.A., P.O. Box 276, S. Glastonbury, Conn.

Mosley Lancer

Mosley's new Lancer 1000 2 kw mobile five band antenna offers a lot of features to the ham. It's made of stainless steel, and uses interchangeable coils for all bands but ten, which is fed direct. If all coils are bought together, they come in an attractive coil caddy for easy, safe storing. For more information, write Mosley at 4610 Lindbergh Blvd., Bridgeton, Missouri 63042.

GE Compactron Catalog

GE Compactrons have made quite a mark in the TV industry. As usual, this has brought many dividends to hams. The small, reliable, multi-purpose Compactrons have many ham uses—and are being used by many ham manufacturers and ham builders. An interesting catalog of Compactrons and their advantages over other tubes is the new GE publication ETG-3983, which you can get by writing GE, Schenectady, N. Y.

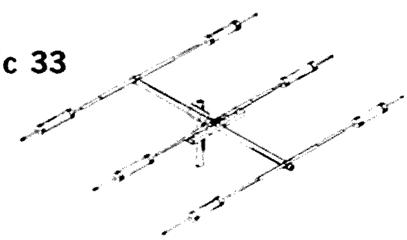
National Reduction Drives

National Radio has recently announced a new line of 10:1 and 5:1 ball reduction drives that require only one inch-ounce input at no load, but can transmit outputs of 35-40 in-oz. They're smooth and virtually back-lash free. For more information on these drives, please contact National Radio, 37 Washington St., Melrose, Mass. 02176.

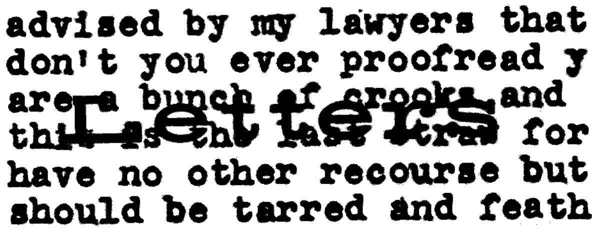
GE Semiconductor Guide

The new General Electric Semiconductor Almanac is a must for servicemen and experimenters alike. Under the slogan, "A few will do," GE has devised a cross index to all sorts of transistors, diodes and other components, that tells you which of the readily available GE Universal Replacement Transistors will replace which other transistors, etc. Like the RCA SK-line, these transistors (GE-1, GE-2, etc.) are a little more expensive than some others you can use for similar applications, but unlike other transistors, are available at most distributors. Get your copy of the almanac at your local distributor.

Mosley Classic 33



Mosley's new Classic 33 triband beam is their newest addition to the Trap-Master family. The Classic will handle 1 kw AM/CW or 2 kw PEP SSB and features a new type of matching developed by Mosley, "Broad Band Capacitive Matching." The beam features a long boom for excellent gain and assembled weight is only 60 lbs. For more information, write Mosley, 4610 North Lindbergh, Bridgeton, Missouri 63042.



Dear 73:

I am not a V.H.F. man, but I do know my math! Your illustrator shows the curvature of the parabolic reflector ("Design of Parabolic Reflectors", February, 1966) as being greatest at the ends.

The curvature actually decreases as the distance from the axis is increased, since the curvature is proportional to $1/(z^2)$, which also decreases.

It makes no difference in the actual construction, of course, so long as one sticks to the equations given, but some of your readers may be worried if their dishes don't look like the illustrations!

Please excuse the criticism, but as a teacher of Engineering Graphics, I guess I'm a bit fussy about accurate drawings!

Mike Guérard WA5JMY
Bryan, Texas 77801

Dear 73:

Lately I've seen the concept of "noise figure" and "noise factor" treated loosely; however, I have had no objections because, in general, most readers gain additional insight to the general concept of noise (whether it is generated externally or internally to a receiving system) and how it effects receiving sensitivity. But I must object to the February 1966 article "Noise Considerations in a Preamplifier". Author Nelson has fallen into the trap many do in interpreting the equation for determining overall noise figure when adding a low noise preamplifier to a receiver.

The expression $NF\text{ overall} = NF_2 + \dfrac{NF_1 - 1}{G_2}$ is correct. However, NF overall, NF_2, NF_1, and G_2 cannot be used in decibel form in this equation! These terms must be in factor form. Subtracting the factor 1 from NF_1 expressed in decibels is like trying to subtract apples from oranges.

The expression $NF\text{ overall} = NF_2 + \dfrac{NF_1 - 1}{G_2}$ the terms should be redefined as follows:

NF overall = overall noise *factor*
(overall noise *figure* = $10\log_{10}$ NF overall)
NF_1 = noise *factor* of the original system
(noise *figure* of original system = $10\log_{10} NF_1$)
NF_2 = noise *factor* of the preamplifier
(noise *figure* of preamplifier = $10\log_{10} NF_2$)
G_2 = absolute power gain of preamplifier
(decibel power gain of preamplifier = $10\log_{10} G_2$)

In the example problem as given in the article, if noise *figure* of original system = 11db then noise *factor* of original system = 12.6. Also if noise *figure* of preamplifier = 5db then noise *factor* of preamplifier = 3.16 and, if power gain of preamplifier = 10db then absolute power gain of preamplifier = 10.0. Therefore,

overall noise *factor* (NF overall) $= 3.16 + \dfrac{12.6-1}{10} = 3.16 + 1.16 = 4.32$ And, overall noise *figure* $= 10\log_{10} 4.32 = 6.35$db

Just because the author obtained 6db by using the equation incorrectly, the reader must not be misled in believing that the difference between the correct method and the incorrect method of calculating overall noise figure is always small. A few sample problems will soon convince the reader of this.

Robert L. Eison
Ventura, Calif.

Dear 73:

Jim Kyle's "Full Story on Low Pass Audio Filters" in the March issue of 73 was doing fine until he wandered off on the problems of impedance matching (the right hand column of page 94). In the first place he started out to design a filter with a 470 ohm characteristic impedance and then decided to feed it from a 500 ohm source. This is not too bad a mis-match but the idea of isolating the source from the filter is really wild. The idea is to match the source to the filter. This may be done in this case most easily with a minimum loss matching pad. In this case going from a 500 ohm source to a 641 ohm load he should have placed a shunt resistor of 1067 ohms across the 500 ohm source and a 301 ohm resistor in series with tthe 641 500 ohms and the load will be driven from an effective 641 ohm source. The loss of this arrangement will be only 4.346 db rather than the 44 db mentioned in the article. The 44 db loss mentioned in the article is about 9,500 times as much power loss as is obtainable with the above mentioned minimum loss matching pad.

Keep on coming with the good technical and construction articles as 73 is about the only source left among the ham journals for such a profuse supply. The table of contents for one issue of 73 will beat the annual index of the other brands.

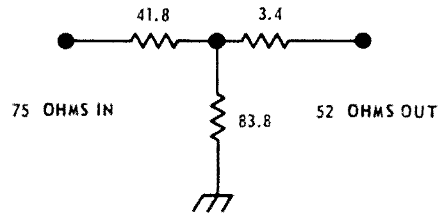
John I. Sheetz K2AGI

Dear 73:

Just a word of appreciation for your magazine. It gives a fresh atmosphere of imagination and originality (and controversy!) in what had become a rather stilted and dull field of technical journalism.

Your articles are always interesting, but occasionally an author gets a bit careless with his slide rule. For instance, "Seeing your SWR" in the February issue offers a new and interesting approach to a perennial amateur problem. However, on page 68, Fig. 6, the values given for the 6 db pad appear to be in error.

For matching a 75 ohm generator to a 52 ohm load with 6 db of insertion loss the values shown below appear to satisfy the conditions:



This error doesn't detract from the usefulness of the article but if someone tried to use the pad he might be disappointed in its performance for anything like precise tests.

Jim Sprong K1YZP/1
Roselie, N.J.

Dear 73:

I would like to thank you for publishing the tongue-in-cheek article "Historical Note" by Ray Thrower WA6PZR, in the March issue of 73.

It takes me back to the days of my youth when my two ambitions in life were to be a Ham, and to be the male vocalist in an all-girl band.

Even in those days I was interested in Broad Bands.

W. H. Rocholl W5ZXZ

Corrections

In VU2NR's transistor receiver in the February issue, each coil L4, L5, L6 should have a grounded center tap.

In the February issue, page 102, "Semimodernizing Vibrator Power Supplies," the center tap of the transformer should not be grounded or poof!

Dear Wayne,

In your January issue you mentioned the UFO enigma. That's been a pet interest of mine for years. In November of '53, the first year the 15 meter band was opened up for phone operation, I conducted the first known UFO seminar on the ham bands on this subject. We met every day at noon California time. There were several regulars who called in daily, some of whom are now among silent keys. These included W6ZZ (deceased) W6BD (deceased) W6IJU, W6OZC (deceased) several other W6's, and many persons from Texas, the east coast, the midwest, Canada, Hawaii, South Africa, Mexico, and occasionally Chile. Many persons told of personal sightings of these strange objects. There was sufficient interest in this topic that the discussion would run for hours daily. I had a tape recorder and whenever a person who was not being copied by other interested parties told a personal sighting story, I would tape record his offering and play it back for the benefit of those who missed it. This discussion group ended late in December when 15 meters became so useless as to become simply a ground wave band. Some interest was revived when the band started opening up again late in February and in March, but by that time many persons in the discussion group had read some of the personal contact stories that were then beginning to appear in book form for the first time and so the subject of personal sightings seemed too tame to hold their interest to a degree necessary to perpetuate the old discussion.

I went further. Being located in California where eccentric stories were more easily told from the platform than in other sections of the U.S., I went to hear some of these contactees such as Truman Bethrum, Orphio Angelucci, George Adamski, Dan Fry, and others, tell their stories in person. I have heard some of them speak twice and three times just to see if they would change their stories. They did not. Naturally, their stories lead the interested to investigate other fields touched upon such as telepathy, reincarnation, and other strange or rather not understood phenomena and I did this too. It seems that after a while one finds himself so bogged down in a metaphysical quagmire of speculation and half truth that he realizes the full truth that one can only accept that which is his own personal experience. The rest of man's knowledge with which he copes during his lifetime is borrowed only to stimulate these experiences. It is said by those who have claimed contact with these beings that telepathy is the means of communication which they employ between their craft and their home planets and that they can indeed, converse across the entire universe. "Time and distance are no barrier" says Remu in George Adamski's book INSIDE A SPACE SHIP. But I cannot confirm this from my own experience and therefore cannot answer your question posed in the January issue.

Donald R. Farnsworth WØJYC
Florence, Colorado 81226

Dear Wayne:

The "gravity-detector" that I have been using for a test of some 40 hours during the past few days would respond to dots and dashes of the morse code if gravity could be controlled in like manner.

In other words if the gravity force was broken up into dots and dashes my "detector" would respond at perhaps 15 or 20 wpm.

Gravity is believed to have a very-very high frequency, way beyond what any detector that we know of would respond to.

The gravity particle (graviton) is supposed to have a wavelength of 6.75×10^{-14} cm. and a frequency of 4.54×10^{23} cycles per second, a mass of 3.351×10^{-24} grams and a volume of 6.3×10^{-12} cm^3. So figure it out, what kind of a circuit and equipment you would use.

We do not know as yet how to vary the gravity field. The earth does it, but we want something much smaller than that.

Thomas Appleby W3AX

Dear 73:

How did that CB'er get on the cover of the March issue of 73? He really gets out—I've heard him around here several times—at least somebody who sounds as he looks.

Maybe he's about to get converted—at least he reads a good magazine.

Jim Hornaday

Dear 73:

In the March 1966 issue of 73 on page 112, Mr. Irwin wrote that he was not a licensed ham (maybe he's an unlicensed one, hi) just because of his attitude toward CW. Also, he wrote he didn't even like the frequency allocations for such. Sounds like sour grapes is written between the lines. And I'd like to see the figures on which he based his statement that "the majority of hams can't and don't use CW." Maybe Mr. Irwin would be happy as a CB'er.

But what really bothers me was that Mr. Irwin had the nerve to ask for "more articles for the SWL and less articles on Xmiters and amplifiers." I don't think he ever noticed the two words that appear regularly on the covers of 73 (to the right of the numeral) that clearly spell out the type of material to be found between covers and specifically for whom. If he wants to read about SWLing, he can read Popular Electronics.

The best thing about 73 is that there is plenty to it. With all the ads in QST, you'd think the ARRL could run a better magazine. 73 to 73.

T. Victor Mukai WB2STR

P.S. Was there some special reason for printing Mr. Irwin's letter?

No.

Dear Wayne,

The story by KØJXO in February intrigued me. The day after my copy arrived, I received one dozen surplus crystals, all marked "400 kc." Ten turned out to be good oscillators. These were checked with a standard oscillator (32 pf input capacity) and a frequency counter. The same variations mentioned were experienced here.

One crystal was within 2 cycles. The rest were off by at least 50 cycles, and in some cases as much as 200 cycles. Average reading was 400,102.4 cycles. This variation might not sound like very much, but when we tried to check the crystal harmonics with WWV, 90% of the crystals were way "out."

For testing, we used only first-class, fixed components, plus an electronically regulated plate supply. Raising the plate voltage from 130 to 195 volts (50%) changed the frequency by only 4 cycles—or 1 part in 100,000. We were able to effect a 30 cycle change in frequency by shunting an additional 50 pf capacitor across part of the grid circuit.

Two conclusions stand out from these tests. One, you can't trust what the label says, as previously stated. Two, you can get a very high order of frequency stability from a properly tuned crystal oscillator, even without the need for a regulated supply voltage. All the crystals were type FT241-A, but it would seem these random frequency characteristics would apply to any given lot of crystals.

Neil Johnson W2OLU
Tuppan, N.Y.

A Simple Damp Chaser

Is dampness in your rig causing drift and component damage? Try connecting a 6 watt bulb across the on-off switch. Put the bulb near the most critical components to keep them warm and dry. If you don't like the light, paint the lamp with aluminum or other heat resistant paint.

. . . K4GRY

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WANTED: Hammarlund HQ-180 buy or trade coins of equal value. Send for list. Walter Jandro, 473 Success Avenue, Bridgeport, Connecticut 06610.

WANTED!—Cash or 6 meter transceiver for HQ-100, Globe Chief, R.M.E. S.S.B. receiving converter, Tapetone 2M. conv, Signal Sentry, Walkie Talkies etc. K1PIC S. Feldman, 31 Goodale Rd., Boston, Mass.,

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RTTY GEAR for sale. List issued monthly. 88 or 44 Mhy toroids five for $1.75 postpaid. Elliott Buchanan, W-6-VPC, 1067 Mandana Blvd., Oakland, Calif. 94610.

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SPRING AUCTION of the Rockaway Amateur Radio Club will be held Friday evening, May 13th. at 8:00 P.M. at the American Irish Hall, Beach Channel Drive (at Beach 81st. Street), Rockaway Beach. Come to the best Auction in the New York area. For detailed directions write to: P.O. Box 205, Rockaway Park, N.Y. 11694.

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QRZ: RME 4350-A. w/spk. $110.00. Knight T150-A $65.00. Both very clean. Twoer, one year old $45.00. WB6PME, Chuck Evans, 2014 Enslen Ave., Modesto, California.

RCA VIDICON 7735A. 15.00, Heath test equipment, 432 KW, Telrex 2 Meter system, 2 meter transmitter, 6 meter converter, 432 grid dip meter, Radar sentry, UHF converter, 2 meter linear, 432 converter and preamp, 2 meter halo; Andrew's HO ⅞" Heliax-Coax, CDR rotor, Tube tester, HO-13 plus more, write for list; Wanted: HP-24, HP-23, IM-30, HO-10. Stan Nazimek WB2GKF, 506 Mt. Prospect Ave., Clifton, New Jersey 07012.

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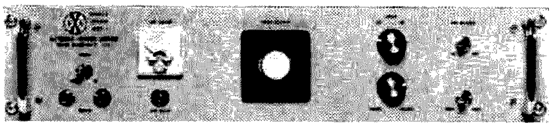
NORTH DAKOTA STATE UNIVERSITY Amateur Radio Society. Annual Hamfest on the NDSU in Fargo, North Dakota, on May 8, 1966. Write WØHSC for more information.



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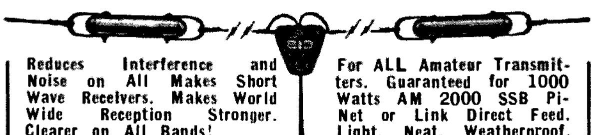

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PRE-STARVED ROCK HAMFEST Dinner Dance. Streator Ill. June 4, 7:00 P. M., Tickets $3.50 Each. Must have reservations by May 21. Contact—WN90MG, Myles Van Duzer, Route 1, Streator, Ill. 61364.

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KWM2A s/n12706 516F 2 real clean $775. ADCOM 350-12 mobile supply new $75. Loudenboomer Linear w/pwrsply New $270. First check gets one or all. W5HBE Box 30241 Dallas, Texas.

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AUDIO FILTERS. Low pass will remove everything above 3300 cycles before it reaches speaker. See the full story in 73 for March 66. These are 500 ohm units, unused top grade military surplus at $2 ea plus about 35¢ postage. Lock City Electronics Box O Freeland, Michigan 48623.

WRL blue book prices save money. Take 10% off these prices without trades. Apollo 700—$199.00; Zeus —$329.95; 75A4—$409.00; GSB100—$179.95; Communicator III-6m—$159.00; SX101A—$209.00; SR150—$389.00; Apache—$139.95; HW32—$119.00; DX100—$99.00; HQ100—$99.00; NCX3—$219.00. Hundreds more. Free List. LEO, WØGFQ, Box 919, Council Bluffs, Iowa.

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MAY 1966

J. H. Nelson

EASTERN UNITED STATES TO:

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ALASKA	14	14	7*	7	7	7	7	14	14	14	14	14
ARGENTINA	21	14	14	14	7	7	14	14	21	21	21*	21*
AUSTRALIA	14	14	14	7#	7#	7	7*	7	7#	7#	14	14
CANAL ZONE	21	14	14	14	7	7	14	14	14	21	21	21
ENGLAND	14	7	7	7	7	14	14	14	14	14	14	14
HAWAII	14	14	14	7	7	7	7#	14#	14	14	14	14
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HAWAII	14	14	14	14	7	7	7#	14#	14	14	14	14
INDIA	14	14	7#	7#	7#	7#	7#	14	14	14	14	14
JAPAN	14	14	14	7	7#	7#	7#	14	14#	14	14	14
MEXICO	14	14	7	7	7	7	7	7*	14	14	14	14
PHILIPPINES	14	14	14	7#	7#	7#	7#	14	14	14	14#	14
PUERTO RICO	14*	14	14	14	7	7	14	14	14	14	14	14*
SOUTH AFRICA	14	7#	7	7#	7#	14	14	14	14*	14	14	14
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ARGENTINA	21	21	14	14	14	7	7*	14	14	21	21	28
AUSTRALIA	21	21	21	14	14	14	14	7	7#	7#	14	21
CANAL ZONE	21	21	14	14	14	7	14	14	14	21	21*	21*
ENGLAND	14	7#	7	7	7	7	7#	14	14	14	14	14
HAWAII	21*	21*	21	14	14	14	14	7	14	14	14	21
INDIA	14	14	14	14	7#	7#	7#	7#	14#	14	14	14
JAPAN	14	14	14	14	14	7#	7#	7	14	14	14	14
MEXICO	14	14	7*	7	7	7	7	7*	14	14	14	14
PHILIPPINES	14	14	14	14	14	7#	7#	7#	14	14	14	14
PUERTO RICO	21	14*	14	14	7	7	14	14	14	14	14*	14*
SOUTH AFRICA	14	7#	7	7#	7#	7#	7#	14	14	14	14	14
U. S. S. R.	14	14	14	14	7#	7#	7#	7#	14	14	14	14
EAST COAST	14	14	14	7	7	7	7*	14	14	14	14	14

Very difficult circuit this hour.
* Next higher frequency may be useful this hour.

Good: 1-3, 6-12, 14-16, 18-20, 25, 26
Fair: 22, 27-30
Poor: 4, 5, 13, 17, 21, 23, 24, 31
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73 Amateur Radio

JUNE 1966

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June 1966

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de W2NSD/1

never say die

My little African safari has expanded a bit. We will now go on a three week hunting safari in August, followed by a three week drive through Kenya, Uganda, Congo, Ruanda, Burundi and Tanzania. From there the air fare is only a little more so we will continue to Lebanon, Syria, Iraq, Iran, Afghanistan, India, Burma, Thailand, Malaya, Bali, New Guinea, Australia, New Zealand, Fiji, Samoa, Tahiti, and back to the U.S. We figure the whole trip for a bit over eight weeks and to run about $2500. We can probably squeeze one more aboard if anyone is interested . . . which I realize is unlikely.

A Walk in the Black Forest

Like millions of others, I've become somewhat addicted to the Tijuana Brass. One of my favorite selections is A Walk In The Black Forest. Did you ever?

I found myself remembering my last trip to Germany and the Black Forest. I was on my way from Stuttgart down to Zurich to visit the moonbouncers HB9RF and HB9RG. The road down there is a fairly narrow winding black top with places every few miles to pull off and park for a picnic or just a short jaunt through the woods. They keep their forests cleaned out of underbrush and you can walk easily for miles if you wish without struggling through bushes and spider webs like we have in our New Hampshire woods.

My arrival in Zurich was a little later than I expected due to a prolonged luxurious rest stop in a beautiful glade. I sat listening to the Schwartzwald music on the FM radio while eating some very black bread and German sausage, washed down by a small bottle of apfelsaft. New Hampshire and 73 seemed a world away. It was nice to relax after several days of furious activity.

A few days earlier I had flown to London for a short visit with the fellows at RSGB. Bus to town, taxi to Little Russell Street, lunch, taxi to airport, and quickly aboard a United Arab Airlines plane for Frankfort. Whew!

Johnny Barrows DL4HU, Lee Forest DL-4LZ and Ed Pahl DL4UL met me at the airport in Frankfort. Johnny was an old friend. We'd corresponded for several years trying to get reciprocal licensing through, only to be thwarted time after time by the ARRL. It is interesting that the League now is taking credit for reciprocal licensing. Oh well. I'd met Johnny when I'd visited the Bitburg club a couple of years earlier.

The airline had managed to lose my bag and it took the four of us a half hour, with the help of Lufthansa to get them to carefully recheck their plane. Sure enough, there was my bag over behind some freight that had just been loaded aboard. I almost lost it for good for I understand that that plane crashed on its way to Cairo after leaving me.

That night Johnny and I kept a sked at one of the great restaurants in Frankfort with Peter HB9PL from Basle. I had made the date on twenty meters a week earlier and it came off smoothly. It was one of those splurge dinners you have once a year (at most) with venison and all the trimmings.

The next day I picked up a Volkswagen 1500S Variant, which I had ordered ahead.

That night I attended a dinner meeting of the newly formed German-American Amateur Radio Club and found nearly a hundred on hand. It was interesting for me to find that this group so far from the U.S. knew more about what was going on than most groups right here in the States. They certainly asked excellent questions.

(Continued on page 151)

Editor's Ramblings

Zip

Mail delivery in the U.S. seems to be at its slowest ebb yet. Service is terrible. It takes as long as three weeks for second class mail to reach the west coast from our printer in Connecticut, and even air mail often takes as long as three or four days. But we have been assured by the Postmaster General, L. O'Brien, that service *will* improve. For instance, he proposes a new class of priority mail to replace air mail and first class. This new class will cost about 7¢, and should provide one day delivery anywhere in the country, certainly a reasonable goal.

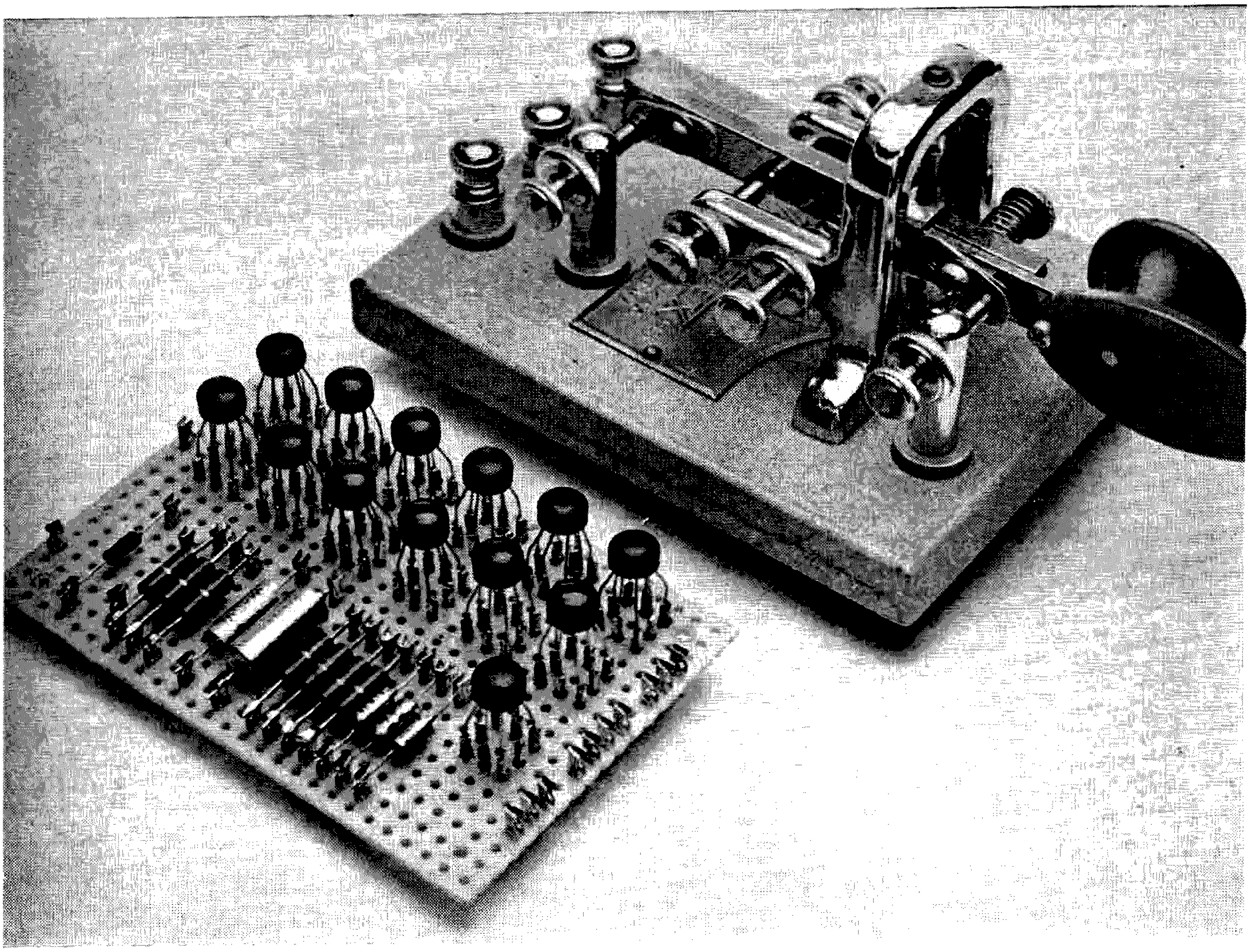
Another improvement the post office is working on is increased automation. To help with this, they have divided the country into small districts, each with a zip code. All bulk mail users and magazines must use zip codes on their mass mailings after December 31, 1966. Most of our renewals are including their zip codes, but we still have many stencils in our lists of subscribers without zips. We have to add the code—a very expensive and time consuming operation—so please help us out a little. Please check the address on the wrapper in which you receive this 73. If it doesn't contain your zip code, or if the zip is wrong, please write the number on the wrapper and send it along to Linda, c/o 73, Peterborough, N.H. 03458. Incidentally, if you will be renewing soon, you can just wait and include the zip then. Please include your zip on all new subscriptions and renewals.

While it's hard to estimate how much right now, this process is going to cost us plenty. We can only hope that we'll be rewarded for the expenditure with decent mail service.

Club special

Ham club secretaries, presidents and editors should make sure that they send us their addresses so that we can tell them about our special plan for club members. It offers a very low price on subscriptions, prizes, and a number of other small benefits such as the background papers that Wayne sends out every once in a while.

. . . Paul



Thomas Pickering W1CFW
991 Middle Road
Portsmouth, R. I. 02871

The Micro-Ultimatic

Integrated circuits in a high-performance electronic keyer

One of the most popular amateur projects over the years has been the automatic keyer. The lever-operated types have ranged from simple capacitor-relay types to the rather complex "Ultimatic".[1] An entirely new concept in keyer simplicity is now available to the amateur in the form of integrated circuits. The Micro-Ultimatic employs IC's in a keyer or extreme stability and reliability, coupled with the ease of operation resulting from the separate dot and dash memories, as in the original Ultimatic. Best of all, the cost for the IC's is about $35.00. To duplicate the circuit using discrete components would require about 110 transistors and a basket of other parts.

It is the intent of this article not only to describe the Micro-Ultimatic but also to provide a primer on simple logic systems and how they can be put together with the type of IC used in the keyer. Thus, you should be able to generate lots of ideas for gadgets which use IC's, and cheaply, at that.

The impact of integrated circuits on the electronics industry has been nothing less than astonishing. IC's have already obsoleted the discrete-component logic circuits in computers and military equipment, and they will soon be found in consumer items and even toys. These digital integrated circuits are a natural for an electronic keyer.

Most of the large semiconductor manufacturers are making IC's. These vary widely in type and price, but most are based on fabrication techniques which put a complete operating circuit with transistors, diodes, resistors and capacitors on a single silicon substrate, and in extremely small physical size. The circuits are made in large batches, sliced apart, and packaged. Packages are typically the "flat-pack," the TO-5 can, or, lately the epoxy encapsulated "pill" similar to the TO-5 shape. These are less costly than the sealed metal cans. The means by which logic functions are performed in each complete circuit or "chip" varies and includes RTL (resistor-transistor logic), DTL (diode-transistor logic), TTL (transistor-transistor logic) and others. Each type has its own electrical characteristics with regard to power consumption, speed, driving power, and cost. But each performs some simple logic function, regardless of how it is accomplished on the chip. The epoxy RTL now made by Fairchild and packaged in the TO-5 type "cans" is the lowest in cost of any IC logic known to the author at present. That's the principal reason for its use in the

(1)Kaye, "The All-Electronic 'Ultimatic' Keyer," QST, April, 1955.

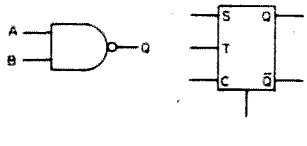


Fig. 1. Functional symbols of two logic blocks. Bottom lead of the flip-flop is P.

Micro-Ultimatic. The logic line is available from many distributors (discussed later).

About binary systems

Since the digital IC is a complete logic package we don't really have to know what goes on inside in order to assemble a system. So first, let's quickly review the fundamentals of a binary digital system.

A binary system is one in which there are only two recognized states. In a typical electronic system, a voltage is associated with each of these states. The states, or levels, are variously called "true" and "false," "1" and "0," "high" and "low," etc. We may choose the terms we want to use. For our purposes here, the terms "high" and "low," I think, help convey more of a physical meaning, since we can associate each with a voltage, one high and one low.

At any instant of time in a binary system the state at any point is either high or low. If it is not one, it is the other. Here we ignore the quite practical fact that in a real-life system some high states may be higher than others. Further, the state at some point in a system is usually the result of the states of one or more points elsewhere in the system. The exact relation between the inputs and outputs of one block of the system is frequently expressed by Boolean algebra, but we can understand the concept by other means.

The NAND Gate

A very useful logic block in a system is the NAND gate. It can be represented func-

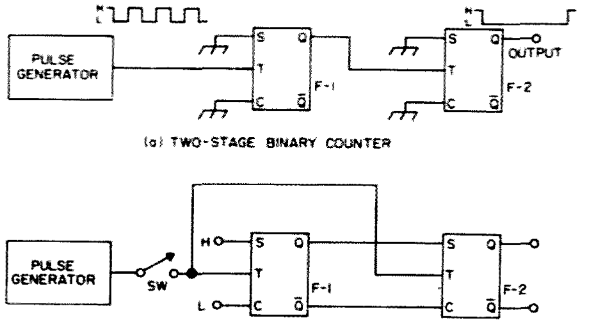


Fig. 2. Two common applications of JK flip-flop.

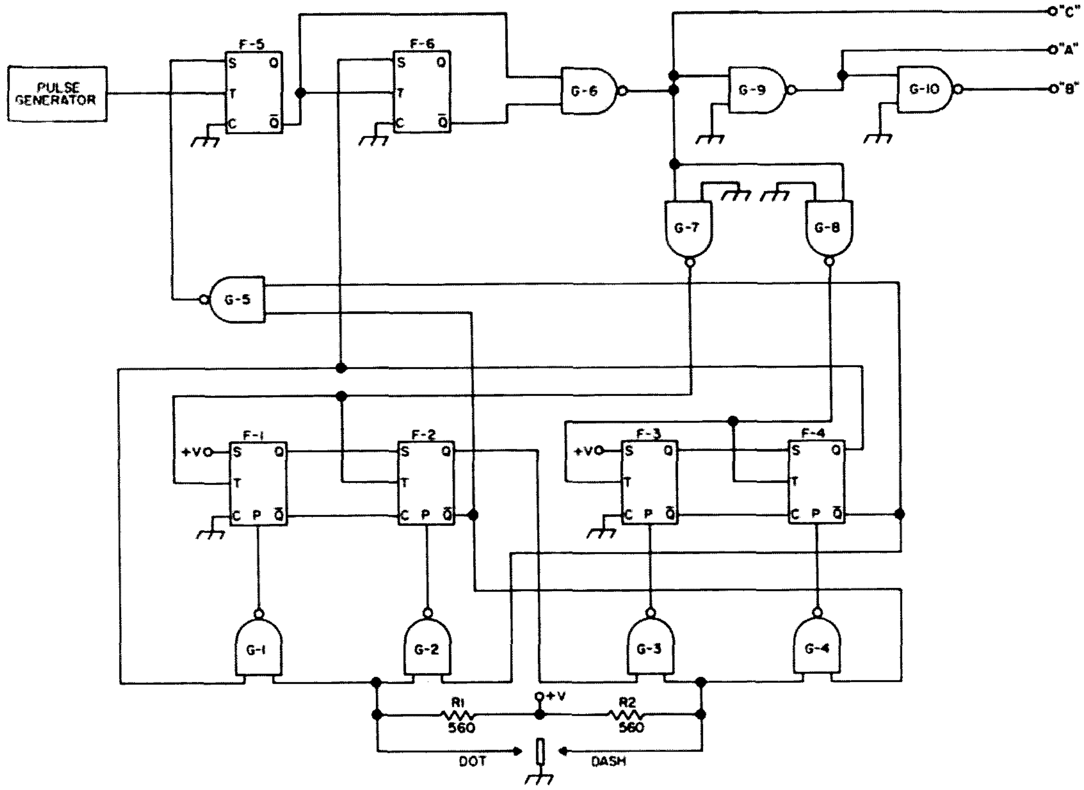


Fig. 3. Block diagram of the Micro-Ultimatic.

tionally as shown in **Fig. 1(a)**. The output Q is related to the inputs A and B in a manner which is readily shown in a truth table. This is a table which expresses all possible combinations of output and input states for the logic block considered. Here is the truth table for a NAND gate:*

A	B	Q
L	L	H
L	H	L
H	L	L
H	H	L

(H = high; L = low)

The table shows that the output of this gate is high (H) only if both inputs are low (L). Any other input combinations result in a L output. We have chosen the NAND gate for this example because this is the gate used in the Micro-Ultimatic. Note that if we permanently connect one input to L, the gate becomes an inverter, whose output is always the complement (or inverse) of its input. This connection eliminates the last two rows of the truth table. The remaining two rows show B and Q to be in inverse relationship. By combining NAND gates, complex systems can be formed; in fact, an entire computer can be built from combinations of this logic block.

*The purist would also point out that this is the truth table of a NOR gate or a NAND gate. We will not go into that here.

The Flip-Flop

If one of the inputs to **Fig. 1(a)** changes, the output may change. The *time* required for this change is considered to be zero in theory. Thus the NAND gate does not possess memory. The memory or storage function is performed by a flip-flop. We will restrict our discussion to the type of FF used in the keyer. Its functional diagram is in **Fig. 1(b)**. The FF has two outputs, Q and $\overline{Q}$. $\overline{Q}$ is simply the complement of Q. If one is high, the other is low. Q is the nominal output of the flip-flop; $\overline{Q}$ is the inverted output. In the keyer analysis which follows, when we speak of the state of the FF, we mean the state of Q. Input pulses from a clock or other sources are normally applied to the T (trigger) terminal. The state of Q after the

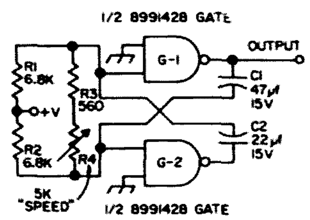


Fig. 4. Schematic of the pulse generator.

trigger depends on the states of the S (set) and C (clear) inputs at the time of the trigger. In other words, the trigger can cause a change in Q; S and C determine what the change will be. Q remains in the new state until another trigger pulse is applied. We may set up a truth table for the FF, as follows:

(Before Trigger)		(After Trigger)
S	C	Q
H	L	H
L	H	L
L	L	Reverses
H	H	No change

The response of the FF to the trigger thus depends entirely upon the S and C inputs prior to the trigger. Note that connecting S and C to low causes the FF to reverse its state on each trigger pulse. This type of FF is known as a JK flip-flop, and the S and C leads are sometimes called the J and K leads. **Fig. 1(b)** also shows a P lead. This is for presetting the FF; a high level applied at P will make Q low.

Two common uses to which the JK flip-flop is put are as a binary counter element ınd as a shift register element. **Fig. 2(a)** is ı two-stage counter consisting of two FF elenents and a source of pulses. By connecting he S and C leads of F-1 and F-2 to low ground) the output of each FF reverses each ime its input signal makes a transition from ıigh to low. This is as shown in the truth able above. In **Fig. 2(a)** the F-2 output requency is at ¼ the input pulse rate. More tages can be added for further frequency livision. This FF application is used in charcter generation in the Micro-Ultimatic.

The second common FF application is also mployed in the keyer. It is the shift register, ıown in **Fig. 2(b)**. Assume both F-1 and F-2 re low; that is, the Q lead of each is low. Iote that the S and C leads of F-1 are ›nnected to high and low respectively. When ıe switch is closed, the first H-L transition om the pulse source will flip F-1, leaving high; F-2 will remain low, since its S lead as connected to the output F-1 (low) before ıe trigger. After the second pulse, however, -2 will flip to high in response to the H put on its S lead. If more stages were lded the H output would propagate down e line, one stage per clock pulse. The shift gister thus acts as a sort of scanning device, multiple-position switch. The output of the st stage can be tied to the input of the first r use as a re-entrant shift register or ring unter.

We have reviewed a little elementary binary

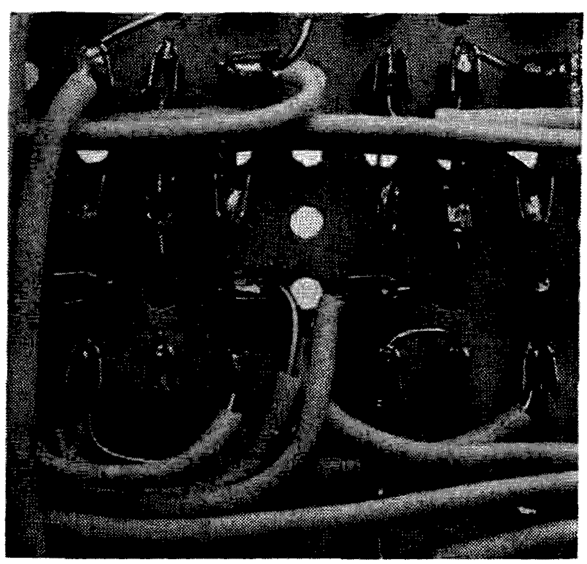
Details of clip mounting. Clips for IC's are mounted upside down.

logic and looked at the two logic element types used in the keyer. Now we can discuss keyer operation. First, let's define a few terms:

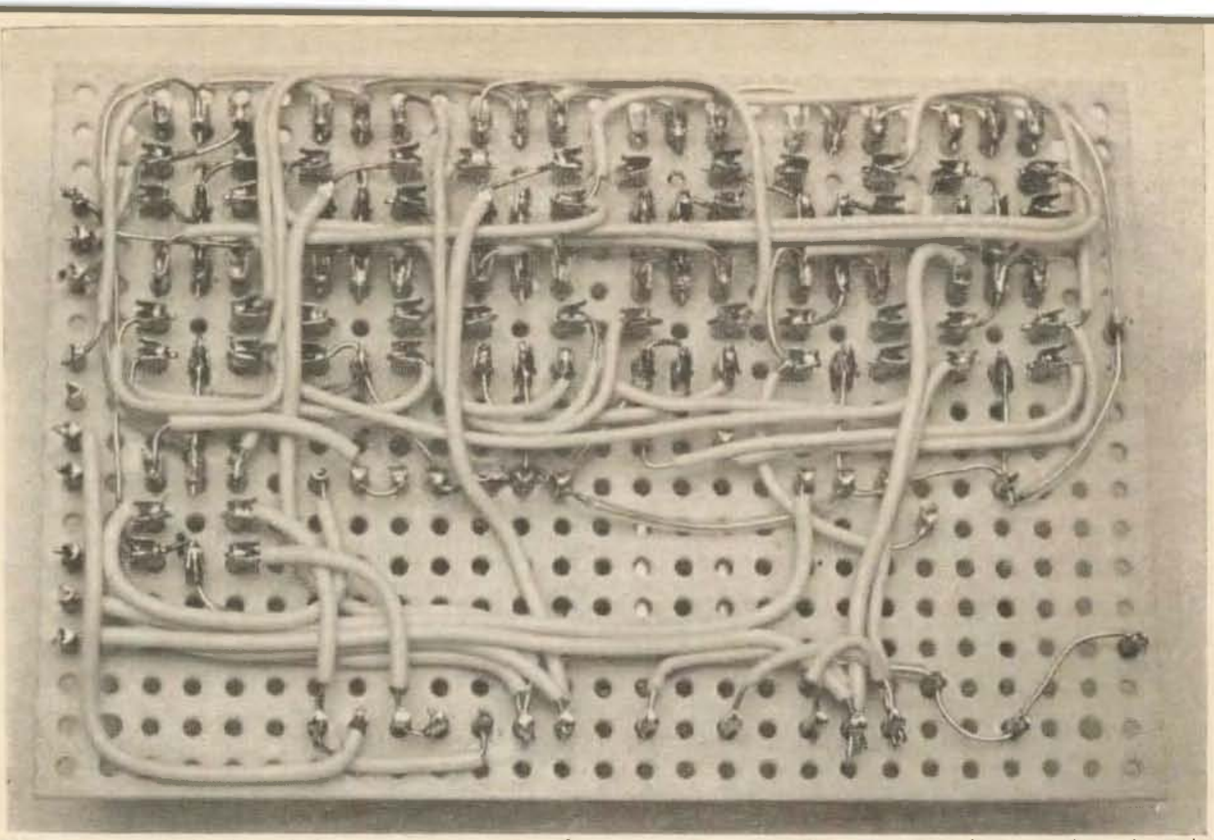
Logic States:	H (high) = 3 volts. L (low) = 0 volts.
Flip-Flops:	FF is SET if Q is low. FF is CLEARED if Q is high.
Trigger:	A high-to-low transition.

Operation of the Micro-Ultimatic

A block diagram of the keyer is shown ir **Fig. 3.** Actually this is almost the schematic



Close-up of wiring side of board.

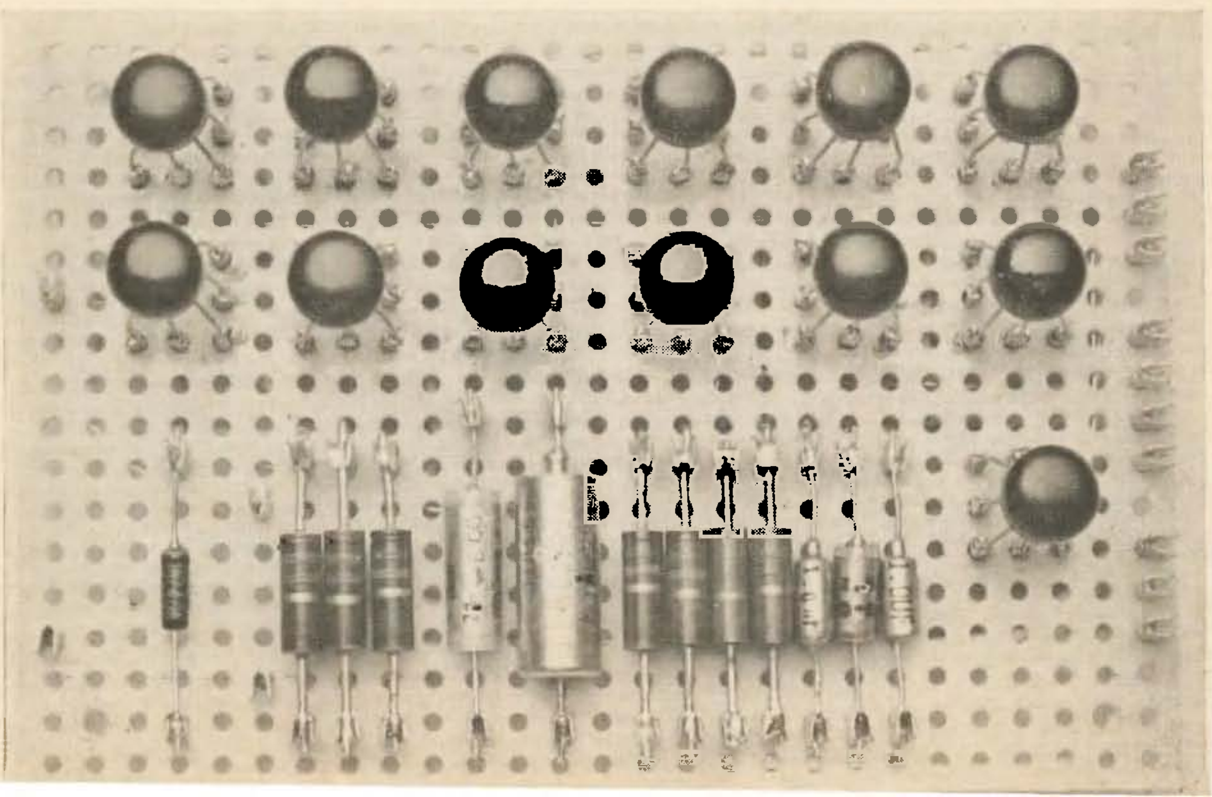


Wiring side of the board. Lay in power wiring first, then signal wiring. A printed circuit board might make things look a little neater.

since most of the discrete components are gone. A few are required for the pulse generator, described later. The character generators are F-5 and F-6, a two-stage binary counter. F-1 and F-2 are a two-stage shift register as are F-3 and F-4. G-9 and G-10 are two gates wired as inverters. They provide two complementary outputs so that either mark or space can be high or low, as subsequent circuitry requires.

In the idle state all flip-flops are cleared. This means that G-5 has L on both its inputs; its output is H, preventing F-5 from toggling in response to the pulse generator which runs continuously for accurate character formation. This method, by the way, produces precise dot-space ratios of unity, regardless of speed. One side of G-1, G-2, G-3, and G-4 is at H level due to the connections to +V through R_1 and R_2. G-1 also has another H input due to F-4; G-3 has another H input due to F-2.

Top of board. IC's are, left to right (top row) G-5/G-6, F-5, F-6, G-1/G-2, G-3/G-4, G-9/G-10. Bottom row, Pulse Generator, G-7/G-8, F-1, F-2, F-3, F-4. Monitor IC is in lower right.



G-2 and G-4, however, each have an L input on one leg. If the key paddle is moved to dots, G-2 will see L on both inputs. Its output will become H, setting F-2, which then applies H to one side of G-5 which then applies L to the Set lead on F-5. The next clock pulse will flip F-5 to the Set condition. This causes G-6 output to go low, driving output A up to high and B to low, initiating a dot. G-7 and G-8 outputs are now at H level, feeding the T inputs of F-1, F-2, F3 and F-4. When the next clock pulse arrives, F-5 will be cleared, the keyer output will revert to idle, and the G-7/G-8 outputs will drop to L. This transition will clear F-2, since its S and C leads were at H and L respectively, due to F-1. The dot is now complete. Nothing else can happen in the character generators until the next clock pulse. If the paddle had been held to dots, F-2 would have remained set and dots would have continued.

To generate a dash, tap the lever to the dash side, setting F-4. G-5 output drops to L permitting F-5 to toggle, as before. However, F-4 has now applied L to the S input on F-6, and after the second clock pulse clears F-5, the H-L transition on the $\overline{Q}$ output of F-5 toggles F-6 to continue the mark condition. Two more clock pulses will leave both F-5 and F-6 cleared, and F-4 will clear as the G-7/G-8 output falls to L. The dash is thus complete.

The description so far is that of a complete keyer, although F-1 and F-3 have not been used. In fact these two may be deleted, along with G-1 and G-3 and you still have a keyer. F-1 and F-3 provide the dot and dash memory. These are extremely useful at moderate and high speeds. When sending letters with a terminal dot, such as N, C, F, etc., it is easy to miss that final dot unless you are there with the paddle at the right time. The dot memory takes care of this for you. As soon as the final dash of the C (for example) is on the air you may tap the paddle quickly to the dot side. The keyer will complete the dash and then add the dot. In fact, you can make the dot movement during the space between the dash and the final dot. Operation at low speed demonstrates this. With the speed pot at minimum, quickly flip paddle from dash to dot and let go. If your action occurred during the interval between clock pulses, you may even have released the paddle before the character starts. A perfect N comes out, regardless. Once you use the dot memory it will be hard to see why more keyers don't employ it. The dash memory serves a similar purpose on letters with a terminal dash. If you have separate dot and dash paddle switches, the memories become even more useful. See reference (1).

Operation of the dot memory is as follows: Tap the paddle quickly from dash to dot. F-4 will be set first. However, instead of setting F-2 on the dot side, F-1, the dot memory will be set, since F-4 applied H to G-2 and L to G-1. F-4 will cause a dash to go on the air, as usual. When it is complete, the shift-register action of F-1/F-2 will shift the L from F-1 into F-2, leaving the keyer in the dot-generating state. The dot will go on the air, after which F-2 will be cleared. A similar action takes place in the dash memory on letters such as A, K, Q, etc.

The pulse generator

Almost any pulse generator may be used, but in an effort to keep the keyer on an all-IC basis, a simple astable multivibrator was selected. It consists of a dual 2-input gate, wired as shown in **Fig. 4.** R_3 limits top speed. The speed range is about 8 to 45 **WPM.** It would be better to use a log pot for R_4, since the resistance-speed relation is quite non-linear. To increase the top speed, R_3 may be slightly reduced.

Output circuits

Select the output circuit suitable for the transmitter being keyed. **Fig. 5** shows three circuits which should suit your individual requirements. Since the keyer generates a perfect mark-space ratio, it seems a shame to upset this by using a relay unless it is fast. Circuit (a) is suitable for cathode keying. Measure the key-up cathode voltage and select Q_1 for a V_{ceo} not les than this value. The cathode current should not exceed about $2h_{FE}$ milliamperes, where h_{FE} is the d-c current gain of Q_1 at the desired cathode current. For keying low-voltage VFOs and crystal oscillators, it's unlikely that the current will exceed 10 ma. If you are still keying things like 6L6's circuit (c) may be better, since the key-up voltage in such tubes may run well over 100 volts. Some transistors suitable for Q_1 are the 2N3402, 3414, 3845-A (all 25 volts V_{ceo}), and the 2N3404 and 3416 (50 volts V_{ceo}). These are inexpensive GE types. There are lots of others. Use a low-leakage silicon type.

For keying a negative lead to ground, such as in a blocked-grid system, the keyed voltage is again the important item. A PNP transistor must be used, and **Fig. 5 (b)** is appropriate. Q_2 must be a germanium type and CR_1 must be silicon. R_1-CR_1 form a bleeder circuit from

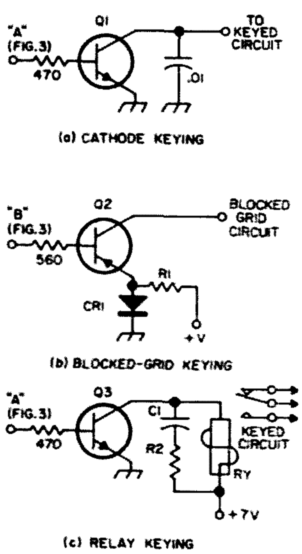


Fig. 5. Output keying circuits.

the +V supply which keeps the emitter of Q_2 at about +0.75 volts. Input to Q_2 is taken from the "B" output of **Fig. 3**, so that in the space condition Q_2 is reverse-biased and no current flows in the keyed circuit. When "B" goes to ground during mark, the forward emitter-base voltage provided by CR_1 is sufficient to turn on Q_2. Actually, the blocked-grid line will be pulled up a bit past ground, to about +0.5 volts, but this should be no problem. Choose Q_2 for a V_{ceo} not less than the keyed line voltage. R_1 is determined by the keyed current. For a current of 10 ma, R_1 should be about 220 ohms. Nearly all the keyed current flows through R_1, and its value should be such as to produce no more than about 2.2 volts drop. This same current flows out of the +V supply and therefore represents an additional drain which must be considered. There are many transistors suitable for Q_2. If the keyed voltage does not exceed 40 volts, the 2N404-A is satisfactory. For keyed voltages under 25 volts, choose any germanium PNP with an h_{FE} of over 25 and V_{ceo} of 25 volts. For voltages up to about 100, the 2N398 is recommended, although the keyed current may be limited by the lower h_{FE} (20) of this type.

For situations requiring a relay, **Fig. 5(c)** is appropriate. Few relays known to the author will operate fast on a 3.6 volt supply, so

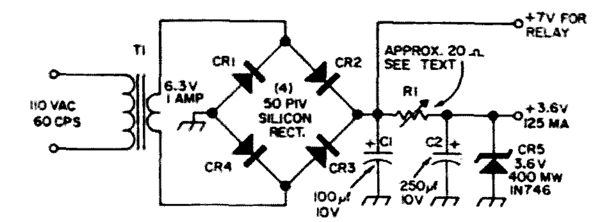


Fig. 6. Power supply schematic.

take the relay voltage from the point shown on the power supply schematic. This will be about 7 volts and should handle a small relay such as the Sigma 4F-1000 type. Q_3 should have a V_{ceo} of around 25 volts. Suggestions for Q_3 are the same as those for Q_1 above. It is advisable to protect Q_3 against inductive transients by the C_1-R_2 network shown. The values will depend upon the relay used.

Power supply

Collector supply requirements for the Fairchild IC's is quoted as +3.6 volts ±10%. The keyer performs well at less than 3.0 volts at room temperature, and were it not for the 120 ma current drain, a pair of flashlight batteries would be ideal. A simple ac supply is shown in **Fig. 6.** The current drain is nearly constant under mark or space condition, so load regulation is not required. The 3.6 volt zener is highly recommended as protection to the IC's against line voltage surges. Zener current should be set to about 20 ma by adjusting R_1 under load. If the supply is run without a load, the zener may overheat.

Monitor oscillator

A simple monitor may be incorporated in the keyer, using the circuit of **Fig. 7.** This is nearly identical to the pulse generator except for time constants. The output is a stout square wave of about 3 volts peak-to-peak and gives ample headphone volume. Control of the monitor is taken from "C" and "B" of **Fig. 3.** These two leads are in phase opposition; one is high when the other is low. Their alterations cause the monitor oscillator to start and stop in accordance with the transmitted signals.

Construction

Since only two types of IC's are used in the keyer, you can convert **Fig. 3** into a schematic, knowing the pin connections to the IC cans. They are shown in **Fig. 8.** Since there are two gates per can, I suggest you combine the gates in the following manner: G-5/G-6, G-7/G-8, G-9/G-10, G-1/G-3, and G-2/G-4. The pulse generator and the monitor oscillator each require a whole can. The keyer is mounted on a piece of Vectorboard about 4 x 2⅜ inches. This is cut from the sheet at a 45-degree angle to produce a square hole pattern with holes on 0.141-inch centers. The IC mounting is made easier. Eight clips are used for each IC. Clips are arranged in a square, two holes on a side. Insert clips from the bottom of the board to simplify soldering in the IC's after all wiring below is complete.

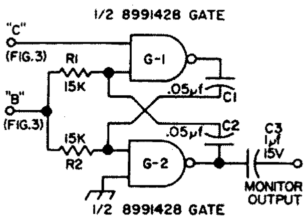


Fig. 7. Schematic of monitor oscillator.

Clips for discrete components are mounted in the usual manner. If you want to try for PC board mounting, go ahead, but I think you will need a double-sided board. A note on wiring: The clip spacing is small and there's little room to work. Wiring is a bit easier if you use #24 or #26 tinned wire and slip some sleeving over each lead as it is wired. Don't forget the power wiring! Pin 8 of every can goes to +V; pin 4 to ground. After all wiring is completed, turn the board over, clamp it in place and solder the IC's in, after first pre-tinning each clip. Hold each IC lead in turn with tweezers while soldering. There are 104 such connections; don't rush the job. Ground pin 6 to F-5 and F-6.

Sources for the IC's

For reasons unknown to me, some of the major suppliers do not seem to handle Fairchild semiconductors. However, other distributors do. The quoted small-quantity prices are \$3.95 each for the Flip-Flop and \$1.65 each for the gates. To order, specify Fairchild JK Flip-Flop, type UX8992328X. The gate is the Dual 2-input gate, type UX8991428X. A letter to Fairchild Semiconductor, 313 Fairchild Drive, Mountain View, California will get you a list of distributors who stock the IC's.

Simplified keyer

If you don't want the memories the cost goes down a bit. Simply omit F-1, F-3, G-1, and G-3. Tie the F-2 and F-4 Set inputs to +V and the Clear inputs to ground. If you ant to eliminate only the dash memory, mit F-3. Disconnect G-3, but G-1, in the ame can, is still required. These simplifica- ions will reduce power supply load and you will have to readjust R_1 of **Fig. 6.**

ome final comments

The current through the key paddle is on he order of 400 microamperes. At this low level it is essential that the key contacts are kept clean, and further, that the continuity between system ground and the key lever be ept constant. This circuit may include a bearing and if a flexible jumper does not bypass this bearing there can be erratic operation. Some of the key paddles designed for use with electronic keyers have considered this problem; others have not.

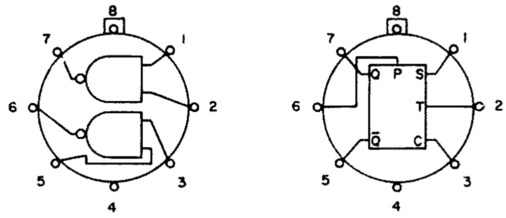


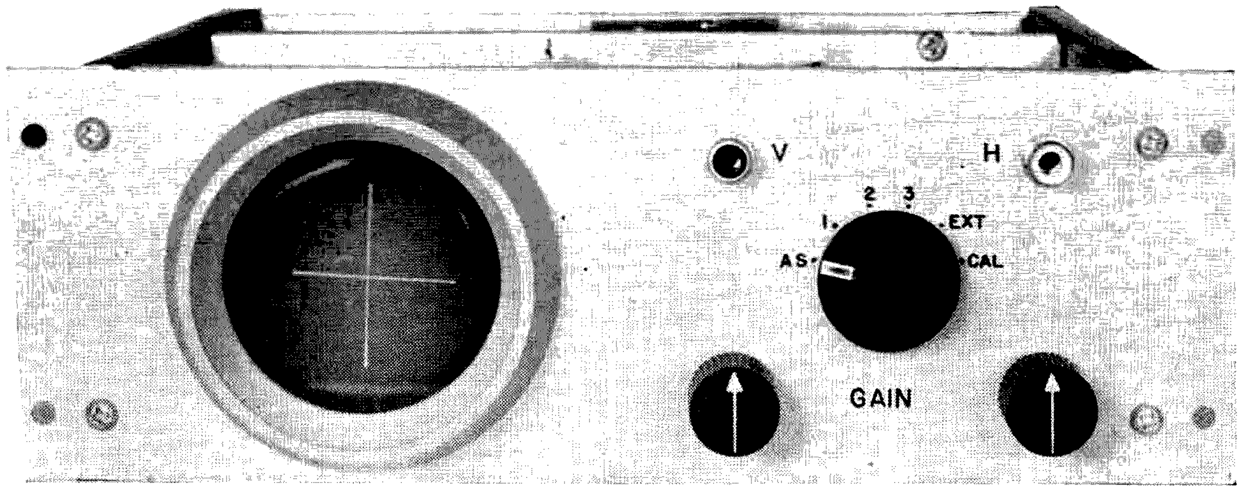
Fig. 8. Bottom view of Fairchild gate and flip-flop IC's. Note: Pin 8 of all modules goes to +3.6 volts; pin 4 to ground.

Trouble shooting if required, is simple. An ordinary multimeter may be used effectively. When a circuit point is supposed to be low, it should read not more than about +0.18 volts. High level may be anywhere between about +0.95 volts and the full supply, depending on circuit loading. The use of a shielded enclosure is strongly recommended. These logic circuits are extremely fast, and only a hundred millivolts of RF may be sufficient to send the keyer on a wild generating spree. The ordinary aluminum box is quite effective. The use of a pair of 0.01 μf discs at the dot and dash input terminals is useful in case of stray RF. Also, use a small bypass in the output wire to the external circuit. If erratic dash operation is observed but with normal dot generation and memory, connect a 100 pf disc between the output of G-6 and ground. This reduces the very small spike which may result during dash generation when F-5 goes high, triggering F-6 to low. If the spike reaches F-4, it will clear it and terminate the dash.

The IC's used here are specified by Fairchild for operation between 15° and 55° Centigrade (59 to 131 degrees F). The keyer dissipates very little heat by itself (about 450 milliwatts), but the effect of heat generating equipment nearby should be considered.

The Micro-Ultimatic is designed to comply with the loading rules specified for the IC's used; therefore, it may be expected to show the reliability of operation associated with integrated circuits. The author's keyer has been running continuously for four months without a sign of problems. This is the eleventh type of keyer which I've built and it's a honey, the smoothest running and most dependable keyer yet. The real test comes during a contest, and this keyer leaves nothing to be desired.

. . . W1CFW



Tom Lamb K8ERV
1066 Larchwood Rd.
Mansfield, Ohio

A Transistorized Oscilloscope for RTTY

This simple scope used inexpensive high voltage transistors instead of conventional tube-type deflection amplifiers.

Teleprinter circuits are admirably suited for transistorization, as indicated by the number of recent transistor TU designs. These TU's have had to use meters or tuning eyes for tuning indicators due to the difficulty of designing scope deflection amplifiers.

This article will describe a simple (nearly) all transistor X-Y oscilloscope, designed for RTTY tuning, but suitable for general X-Y plotting and frequency comparison work. It incorporates a unique blanking circuit to dim any undeflected spot.

Cathode ray tubes require such large deflection voltages that transistor drivers have been uneconomical and unpractical. Recently several 300 volt silicon transistors have become available to reverse this situation. They are ideal for scope deflection amplifiers. The RCA 40264 ($1.21) uses a small diamond case, with non-standard leads. The Industro Transistor TRS-301-LC uses a standard TO-5 case and was used here. Either will work.

Tom, former W4OEY and W1SMY, is an electrical engineer (MSEE, MIT) for the Tappan Company; he designs microwave ranges. Tom has written many articles in 73, mostly on RTTY.

Amplifier

One of the photos shows an excellent 300 volt p-p sine wave at just below the amplifier's clipping level. This is enough voltage to deflect almost any 2, 3, or 5 inch CRT operated at moderate accelerating voltages.

The amplifiers are quite conventional except for the 300 volt B+. My particular scope obtained full deflection with inputs of only 0.3 volts (RMS) vertical and 0.5 volts horizontal. The input impedance varies with the gain

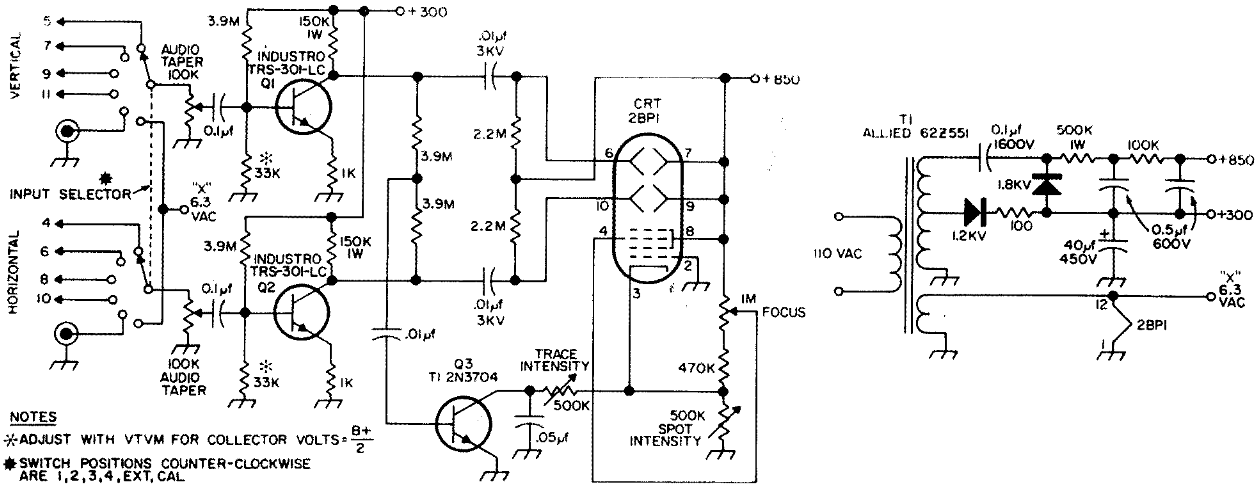
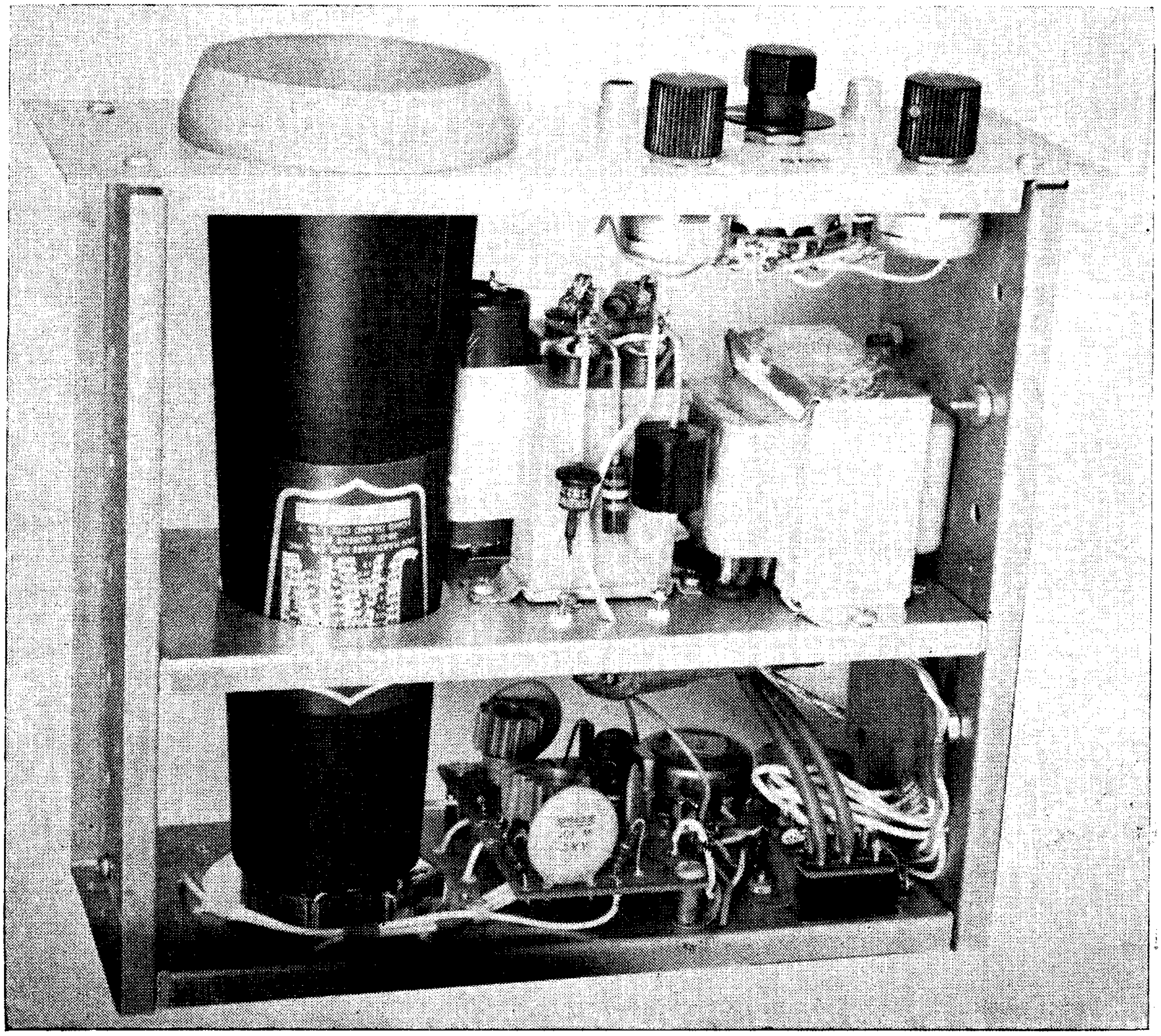
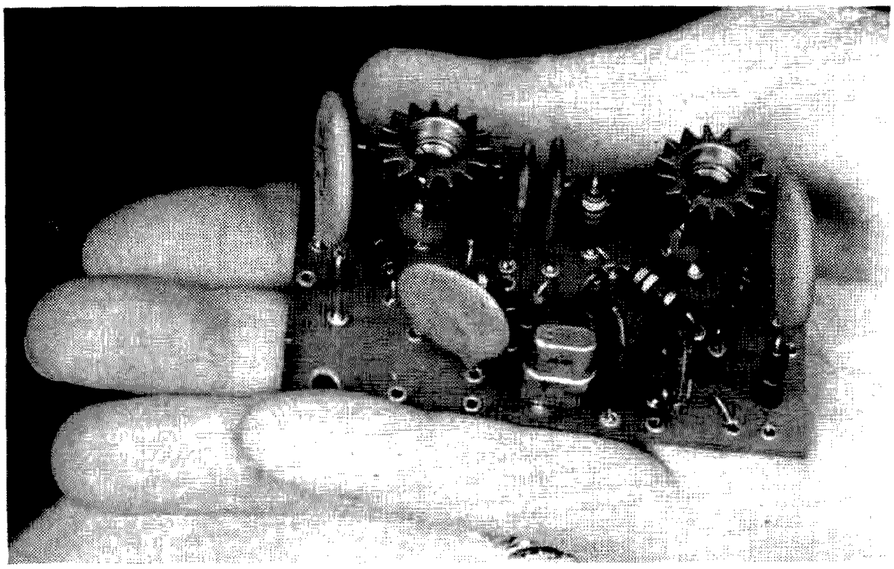


Fig. 1. Schematic of K8ERV's RTTY scope using transistor deflection amplifiers.



Internal parts layout showing the location of the amplifier board, controls, power supply and CRT with shield. The CRT shields are available inexpensively from many 73 advertisers.



Board containing the vertical and horizontal amplifiers and the blanking circuit.

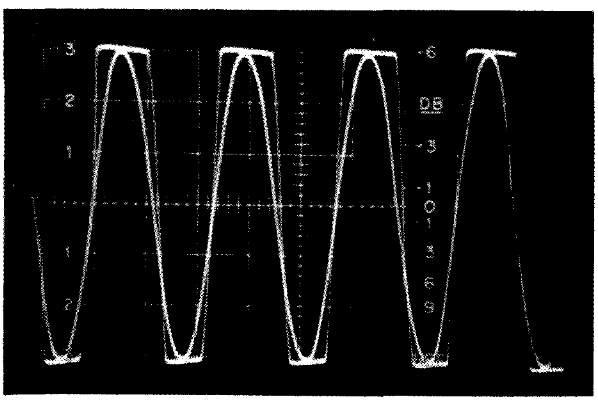
setting from 20 k to 100 k. Higher impedances may be obtained by adding series input resistance. The bandwidth is from 50 Hz to over 20 kHz. The lower response can be improved by increasing the values of the 0.1 μf input condensers. Heat radiating fins on the deflection transistors are desirable but not essential.

Blanker

A particular problem with RTTY scopes is that often an undeflected spot occurs, which burns the screen. With the blanker, the undeflected spot is adjusted for very low intensity with the "spot int." control. Any input signal drives Q_3 into conduction, shunting the intensity control with the second, "trace int." control. This is adjusted for proper operating brilliance. This circuit completely prevents screen burning.

Power supply

The supply is unusual in that only two diodes are needed to supply both 300 volts for the amplifiers and 850 volts in a multiplying circuit for the CRT. Any small 500 volt transformer will work. If the B+ is much over 300 volts, increase the 100 ohm surge resistor. If you need more voltage for a 3 or 5 inch tube, replace the 0.5 M resistor with another 1800 volt diode, and raise the voltage rating of the two 0.5 μf filters to 1000.



300 volt output from one of the deflection amplifiers.

Adjustments

Remove Q_3 from its socket then plug in the scope. Check the B+ for about 300 volts, using a Variac if necessary to keep it down. Connect a VTVM or 20,000 OPV meter on the 500 volt range to the collector of Q_1. Select or pad the base to ground resistor to obtain a voltage of ½ B+. Do the same with Q_2. Now adjust the power supply resistor for a 300 volt B+ with normal line voltages.

Now adjust the focus and spot intensity controls for a small dim spot. Unplug the scope, wait ten seconds, plug in Q_3, and plug in the scope. The spot should be the same as before. If it is brighter, either the transistor or its base coupling condenser is leaky, or the transistor has too low a breakdown voltage.

Obtain a full deflection by switching the input selector to "Cal." and adjust the "trace int." control for a bright sharp pattern. Removing the signal will cause the remaining spot to dim to the intensity set by the "spot int." control.

This scope was built as a separate unit with input selector so that it could be used to monitor several different TU's. It is small enough to be built into compact TU's or other equipment. If you aren't yet using transistors, this is an excellent first project, with practically nothing to go wrong?

. . . K8ERV

Bill Hoisington K1CLL
Peterborough, N. H.

50 Watts on 50 mc for $50

Build this low-cost, simple-to-construct rig for a potent signal on six meters.

Persistently pursuing our policy of building low-cost rigs for various bands from 1296 down to 50 mc this article describes our new 50 watt six meter station using only two low cost tubes in the RF section including a rock-stable VFO. It ought to be rock-stable: it has a 46 megacycle rock in it!

And no frequency multiplication to also multiply drift, FM, hum, etc. I happen to be in a round table with this rig while writing and interest is considerable in a modular type low-cost compact 50 watt rig which also includes VFO. Adverse comments are also being made about small rigs that are rock-bound. Six meters today is definitely a VFO band so this is considered a must for any new home-brew station.

The size is handy, the final being 2 inches high, by 6 wide and 5 deep, and the single tube crystal controlled VFO exciter about the same size. So, enough small talk, let's get into the main course.

It takes a little work to put 50 watts on 50 mc for $50 with a VFO rig. After all though, there are thousands of amateurs who can buy the $300 to $400 rigs, but there are also some tens of thousands who cannot! At least not yet in their careers. But anyone can afford this rock-stable 50 watt rig. Let's add it up: The exciter module comes to about $6 for the capacitors, socket, small parts, etc., if you don't have a junk box and get them all out of the catalog. Tube is $2 and crystal is $4—a total cost of $12 for a rock-stable VFO with one third watt output on 6 meters.

The rf final comes to even less. It looks like about $10 from here including the tube. I suppose someone will write in and say, "Bill, you forgot the hootenany for $1.25." After all, even if you are only 14 years old and don't yet have any junk box at all, you can take apart some old TV sets and start one.

The modulator sure boosts the cost though. It costs $22 for the parts and $6 for the tubes

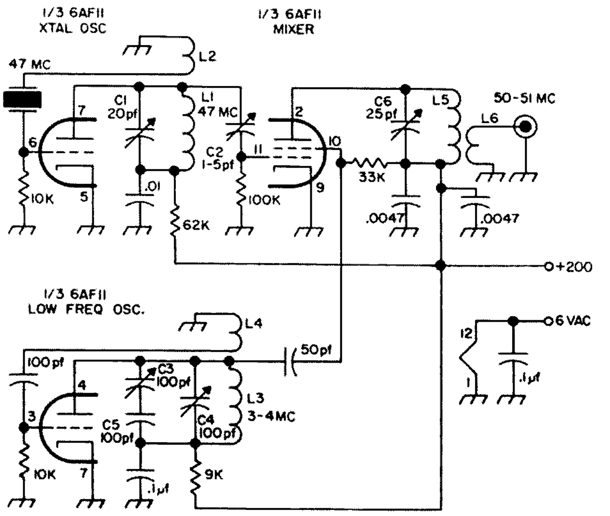


Fig. 1. Six meter heterodyne VFO exciter using one Compactron. Output is about 300 mw.

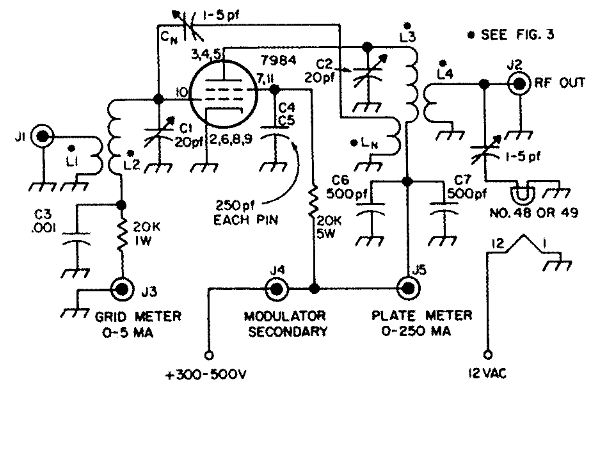


Fig. 2. 7984 Compactron final amplifier. This amplifier puts out over 50 watts with less than one-third watt drive. Note that the tube requires 12 volts on its filament.

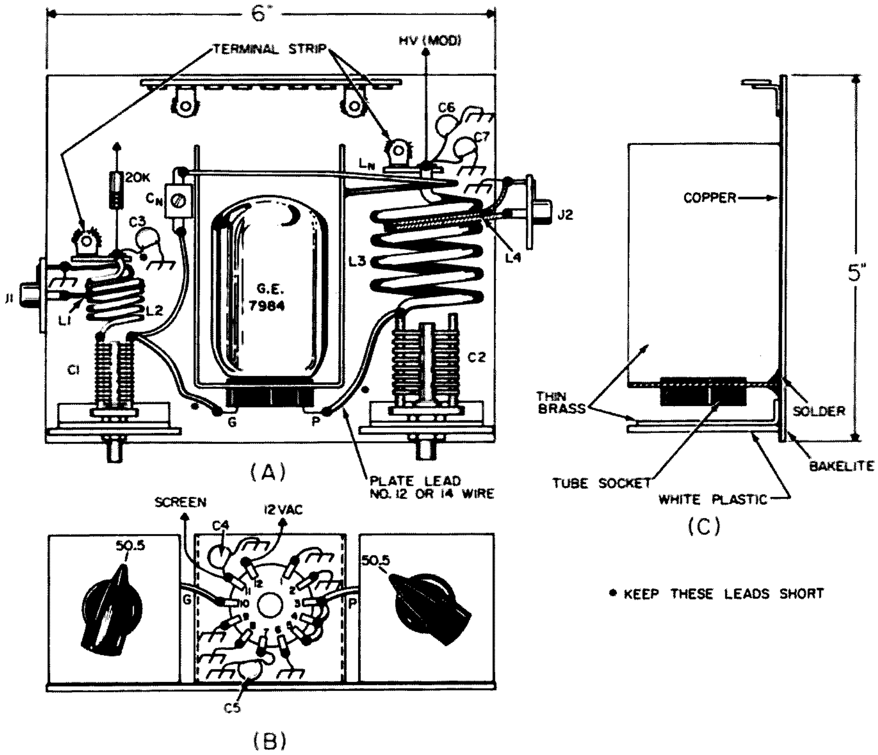


Fig. 3. Recommended layout for the 7984 final amplifier.

for a total of $28. Get busy on that junk box!

So that gives us the whole rig for $50 (less power supply). We made it. But only just, as the Scotsman said counting his change at the bank.

The exciter

The exciter (**Fig. 1**) was covered in the April 1965 issue of 73, but we reprint the circuit here for your convenience. Just to be sure, I built a second one directly from the article and it worked immediately and excellently.

It uses a 6AF11 Compactron tube, which has two excellent triodes for the oscillators and a high gain video pentode for the mixer, all in one little $2 bottle, definitely a bargain.

The principle of using a 46 mc crystal and then adding a 4 to 5 mc variable oscillator in a mixer is a sound one and has been around for many years. Some 90% of the frequency determination is done by the crystal oscillator. Also, any hum, FM, etc., in the 4 to 5 mc oscillator is not multiplied as in conventional VFO transmitters. The results are really worthwhile. I use ordinary 100 pf variable capacitors, copper-clad bakelite base and shielding, no voltage regulator and only one $2 tube. Also, only one crystal. For the whole exciter!

Make sure that you get the 50 mc output and not 46 mc or one of the other frequencies generated in the mixing process. Also don't overcouple the link coupled stages. This will keep down TVI.

The rf output on 50-51 mc is about 300 mw which is sufficient to drive another Compactron, the 7984, to 50 watts output! I got about 2 ma of grid drive.

The plate voltages on the three sections of the 6AF11 are: crystal oscillator, 75 volts; 4-5 mc oscillator, 180 volts, mixer, 275 volts.

The RF amplifier

The modular construction of the exciter and RF amplifier (**Fig. 2**) is quite convenient for building, tune up and final tests on the air. I find that laying the tube on its side as shown in **Fig. 3** with the 12 pin socket centered in a small vertical thin brass panel makes it easy to work on the socket and forms a module only 2 inches high by 6 inches wide by 5 inches deep. Keep the leads short—as is easy to do if you follow the layout—and ground all four cathode leads.

The neutralization system is an afterthought. I went into this subject in the August '65 issue of 73, so instead of having to rebuild the entire rig when self-oscillation showed up, I just added the outboard neutralizing as described. Don't forget that the 7984 is a red hot beam power tube. It takes only one third watt drive from the exciter to light a 50 watt bulb to full brilliancy. Figure that gain out!

To adjust the neutralization, remove the excitation and the output coupling and put enough plate voltage on for about 100 ma plate current. Then adjust CI and C2 for self oscillation (unless you happen to be lucky in

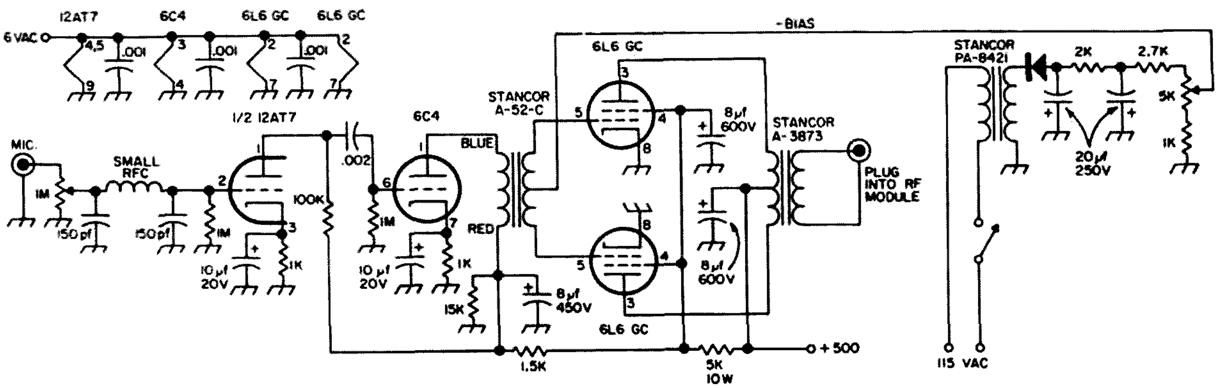


Fig. 4. Modulator and bias power supply for the 7984 amplifier.

your setting of Cn). Some setting of Cn then will give no self-oscillation. Make sure that LI and L4 are uncoupled from L2 and L3 while you're doing this.

You can also neutralize the final amplifier by many other methods, such as no grid current dip when the plate circuit is tuned through resonance, or by looking at the RF output fed through the plate-grid capacitance with a diode detector and no plate voltage. The methods I used worked so easily that I didn't try any others and there has been no self-oscillation since.

Modulator

This is a more or less standard 30 watt modulator using two 6L6GC's as push-pull modulators. Two 6L6GC's can put out 55 watts of audio, yet cost only $2 apiece: they're *the* modulator tubes as far as I'm concerned.

This modulator (**Fig. 4**) has only enough gain for use with a high output microphone such as the Astatic model 150 ($3.82) (−44 db output) that I use. This low gain helps prevent rf feedback into the transmitter and so far I've had no trouble with this normally common problem on VHF.

The modulation transformer I am using is a Stancor A-3873 rated at 25 watts maximum audio output, 8500 ohms plate to plate to a secondard load of 8000 ohms. Maximum DC is 100 ma per side. This is being stretched a little on the modulator side, but so far it's OK. Browsing through the catalogs I see a 30 watt multi-impedance UTC transformer for only $9.30, which should be a good bet.

You can check the modulator with three 7 or 10 watt 110 volt bulbs in series across the modulator secondary and no rf load attached. They should light up quite brightly.

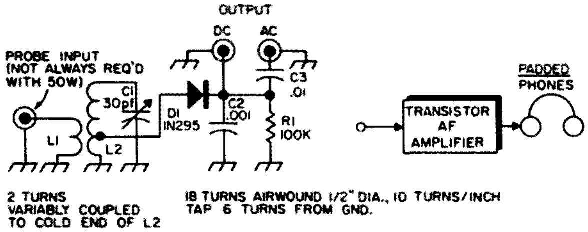


Fig. 5. RF detector for checking the six meter transmitter.

Station assembly

This is an important part of the station, and can really run up the cost if you're not careful. For transmit-receive switching, I use a two position, four pole ceramic switch fastened flat against a copper-clad bakelite panel with three coaxial cable braids soldered to it up real close to the switch contacts. Be sure to use a ceramic switch.

The other three poles open or close the receiver voice coil and switch the 275 and 500 volt power supplies. This is done on the AC side of the rectifiers. There is a slight drift on the crystal VFO as the filter capacitors charge up, but it always settles down immediately to the same spot.

I find it best to use one small power supply for the exciter and a larger 500 volt supply for the modulator and final. Actually, it would be better to use three supplies, with separate ones for the rf final and modulator. You can use any supply you have around from, say, 300 to 500 volts. Over 500 you're on your own.

For carrying the station around, I use a set of wood shelves with the exciter and rf at the top shelf, the modulator next, and the power supply on the bottom, with a piece of dowel across the top for a handle. As you may have read, I have an AC putt-putt and like mountain topping.

RF detector

As I final check I find it indispensible to listen to my own modulation. Also for hum or distortion on the carrier. This is by no means easy to do properly. In fact, for most of my

amateur existence (first license 2BAV in 1923) I relied on reports from other amateurs on the air for modulation checks. The usual receiver does not do a good job at all, as you probably know by experience. What *does* do a good job is a handy-dandy assembly as shown in **Fig. 5.** This set-up with a long pointer knob for good resolution between 46 mc and 50 mc makes a very useful piece of test equipment. Do not use a regular tube type of amplifier. The padded earphones are also a must. It's very simple. With your ears shielded from your own voice as far as sound goes, a good bit of audio gain, you can hear exactly what you sound like, right in your own shack, using a dummy load if you wish. Note that you are listening to yourself on a receiver and you can hear any hum, distortion, feedback, etc., can be heard instantly. You cannot pick up frequency drift or FM on such a receiver, but you can check those on a regular communications receiver.

Four element beam

This rig has been used so far with the four element beam shown in **Fig. 6.** This is a little firecracker and really pushes the signal up about ten times in power (10 db) in one direction while taking it away from another one, of course. I just took the beam down and measured it with a steel tape to make sure the dimensions were exactly correct. If you make it exactly as shown, it will have the same power gain. It's shown as a rigid array, but you can adapt it to portable use with folding joints without too much trouble.

Up to now, I've been using 15 feet of TV masting out on the roof with an armstrong rotator handle just outside the window. It works fine and I'm having no end of fun with it.

So I'm on six meters again, and have chatted with dozens of old friends, and, I hope, made some new ones. I haven't moved out of the shack while building this rig, which means that my junk pile may be a little more extensive than some, after all, it does cover 45 feet long of cellar space, but I *did* look into the catalogues and add up the amateur net prices of the components for you.

It actually is possible to get on the air with *VFO* (this is very important. Ordinary **VFO** asemblies can be expensive) and 50 watts out for $50.

. . . K1CLL

Exciter Coils

L1. 7 turns airwound, 16 turns per inch 5/8 in. diameter. B & W 3003, Air Dux 416T.
L2. 6 turns of plastic covered No. 22, 1/4 in. O.D., 3/8 in. long. Inside L1.
L3. 2 in. of 1/2 in. dia. 32 turns per in. B & W 3004, Air Dux 432T.
L4. 15 turns of No. 28 dcc wound on cold end of L5.
L5. 13 turns airwound 8 tpi.
L6. 2 turn adjustable link over cold end of L5.

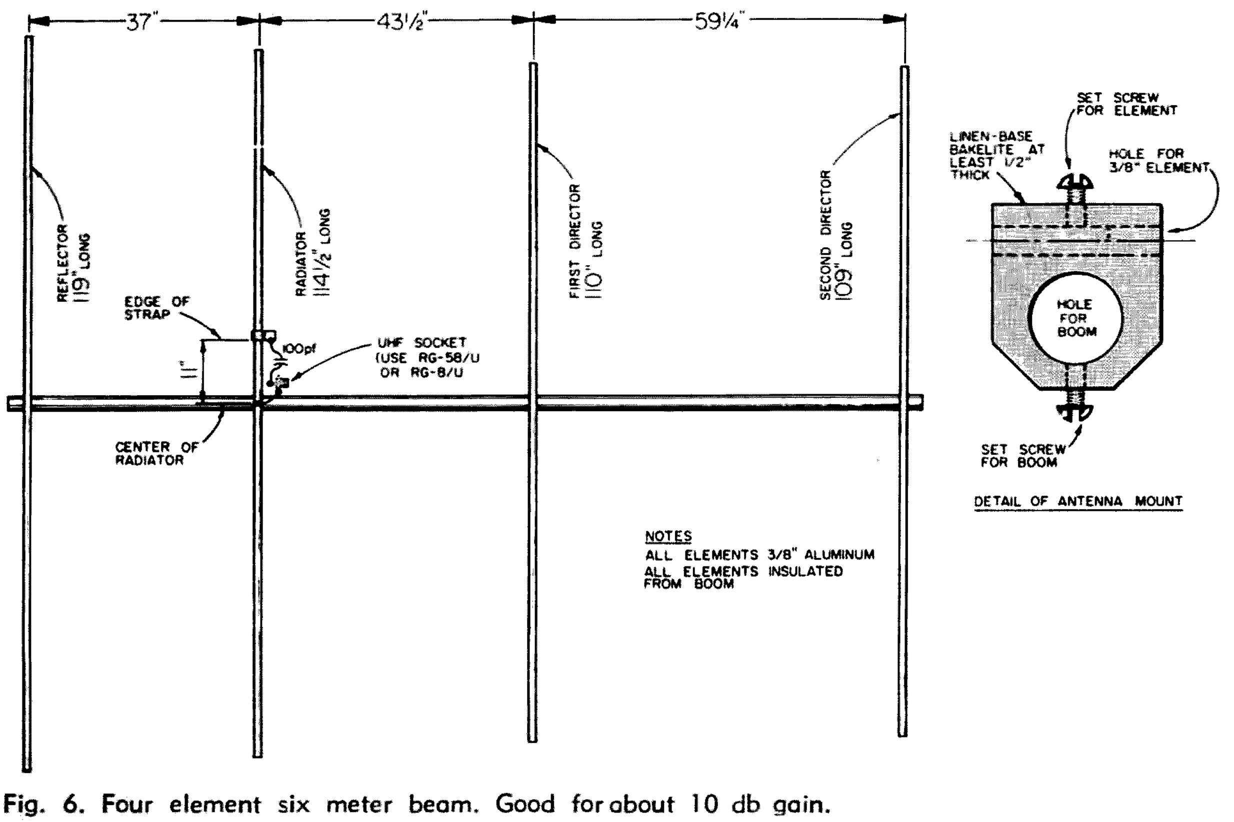


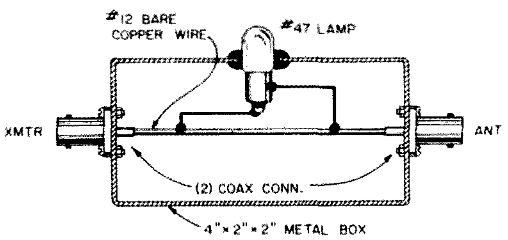
Fig. 6. Four element six meter beam. Good for about 10 db gain.

John Weatherly K1ZYG

The Dummy Loader

Did you ever wonder whether your RF was actually getting to your antenna or merely heating up the shack? The Dummy Loader is a gadget which indicates to dummys like me that the RF is in fact where it should be. Remembering that commercial transmitters use a sampling current for this purpose I figured I better have one, but RF Ammeters are expensive and there is an easy way to do essentially the same thing.

Take a small metal box about 4"x2"x2" and remove its cover. In each end of the box install a coaxial connector of the type suitable for the transmission line being used. Between the center contacts of the connectors solder a length of bare #12 copper wire. Now find a 6.3 pilot lamp (#47) and solder a pair of 2" leads to it. One of these two leads is now soldered to the center contact of either of the connectors. Next connect the gadget into the transmission line *on the output side* of the antenna change over relay and connect the feed line to the other end of the gadget. Make certain at this point that the coaxial connectors are making good electrical contact with the box.



The Dummy Loader. Use coax connectors to match your system.

Apply power to the rig in the normal manner. At resonance lightly touch the free lead from the bulb to the #12 wire at a point about one inch from the soldered connection of the bulb. At this point observe that the lamp barely glows. (If not, turn out the lights in the shack or slide the loose contact along the #12 wire until a small glow is seen.) Retune the rig for *maximum* bulb brilliance. CAUTION: If you get too much brilliance the lamp will not last and power will be lost. When you have found the right spot TURN OFF THE TRANSMITTER and solder the connection to the copper wire.

At the center point of the cover plate drill a 3/8" hole and fit it with a grommet which will allow the grommet to hold the lamp securely. Slide the lamp into the grommet and secure the cover to the box and the job is complete. The device can be and is intended to be left in the line at all times since the power required to light the lamp is negligible as compared to the 50-100 watt input to the transmitter for which it was designed. If lower power operation is used change the bulb to a 1.5 volt type and readjust the sliding contact. So get busy and watch your contacts increase.

. . . K1ZFG

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144 mc Transistor Converter

Build this simple, low-cost transistor converter and filter for a 2.5 db noise figure and lots of DX.

The units shown in **Fig. 1** and **2** and in the photographs are part of the system described in a previoust article. The problems encountered in transistor converters were discussed in detail and a 50 mc converter with its associated antenna filter were included. This section concerns the design of a converter and antenna filter for 144 mc band operation.

Two meter antenna filter

The antenna filter is built in a massive type of construction in order to obtain very high Q circuits so that the loaded Q will be only a small fraction of the unloaded Q values. If the unloaded Q is perhaps 1000 and the loaded Q is 25, the circuit loss will only be 2.5% per circuit or 5% for two circuits. This would mean about .5db loss in noise figure which is low enough for good dx reception in a quiet location with a good antenna. The transistor converter shown here has a noise figure of a little under 2db which with the antenna filter adds up to 2.5 db. If the coax antenna feeder has a loss of from .5 to 1 db, the net NF amounts to 3 to 3.5 db which is far below the more usual 5 to 10 db NF of the average VHF station. Even a good parametric amplifier and antenna feeder system is seldom more than one db better than the transistor converter shown in **Fig. 2**. 144 paramps are very narrow band units and only function into and out of resistive loads. Any regeneration in the converter rf stage, or change of SWR in the antenna system with rotation of the beam or due to weather changes can make a paramp into a real monster for oscillation instead of amplification. Good ferrite "isolators" to tame a 144 mc paramp cost nearly as much as a radio receiver.

Frank is one of the outstanding VHF authors and this is his second appearance in 73. Last month he described a six meter filter and converter similar to the one described in this article.

Fortunately, new economical transistors are being made available which are better than vacuum tubes for rf amplification at 144 to 148 mc. Each year brings forth some new transistors which are better, and at the moment there is one priced near 50 cents, the TIXMO5, which makes even a good paramp system unattractive for dx reception. In time transistors may reach down near the one db NF which can be used for moon bounce or satellite amateur signals.

These high angle received signals are less troubled by man-made noise if the antenna system has very low side and back lobes of response. Even on reception along the horizon of 144 mc signals it is better to hear external

man-made noise than front end receiver noise. Some operators feel that there is no advantage in getting the receiver NF below the man-made or atmospheric noise level. However, this writer doesn't agree since the human ear is a good differentiator of signal to variable noise level, being able in some cases to reach well below the 0 db signal to noise ratio. Man-made power buzzes, auto ignition and appliance electrical noises and atmospheric static crashes are not too much like the hiss of receiver noise, which means that good *if* noise blanker systems and noise limiters in the radio receiver can be of real service in reception or radio signals. All this means that the VHF amateur should strive for a good low NF in his receiver system.

The converter shown here has a low NF, measuring from 1.7 to 2 db over the range of 144 to 147 mc. Since present day low priced transistors overload easily, out-of-amateur-band strong commercial stations can produce the effect of spurious signals within the amateur bands. This effect is more noticeable in a low NF converter. A good antenna filter ahead of the converter tends to eliminate this problem as long as the signals are not within the pass-band of the filter. The filter shown in **Fig. 1** consists of two tuned circuits, slightly overcoupled, so as to produce a pass band of from 2 to 3 mc with close to 50 ohms input and output terminations. The circuits were made large physically in order to have very low losses and a secondary benefit was obtained. The filter is very effective in preventing spurious signals in the transmitter from getting into the antenna. Both lower frequencies from the exciter stages and harmonics of 144 mc are greatly attenuated in this filter which helps meet FCC requirements. The losses are low enough and the voltage ratings high enough so full legal power may be run in the radio transmitter.

The filter shown in **Fig. 1** was built into a 4 x 3 x 17 inch aluminum chassis and cover. A center shield with top and bottom grounding lips separates the two tuned circuits and the 3 by 3 inch cut out at the low rf potential end acts as the aperature coupling between circuits. This was started as a 2 inch cut out and the coupler used from 143.95 to 145 mc originally, then trimmed out in steps to 3 inches long for bandspreading the filter to cover from 2 to 3 mc width. Each tuned circuit consists of an aluminum plate line 16 inches long and 1.5 inches wide supported by an additional .5 inch right-angle lip for grounding and by two ceramic insulators as indicated in the sketch of **Fig. 1.** The tuning capacitors

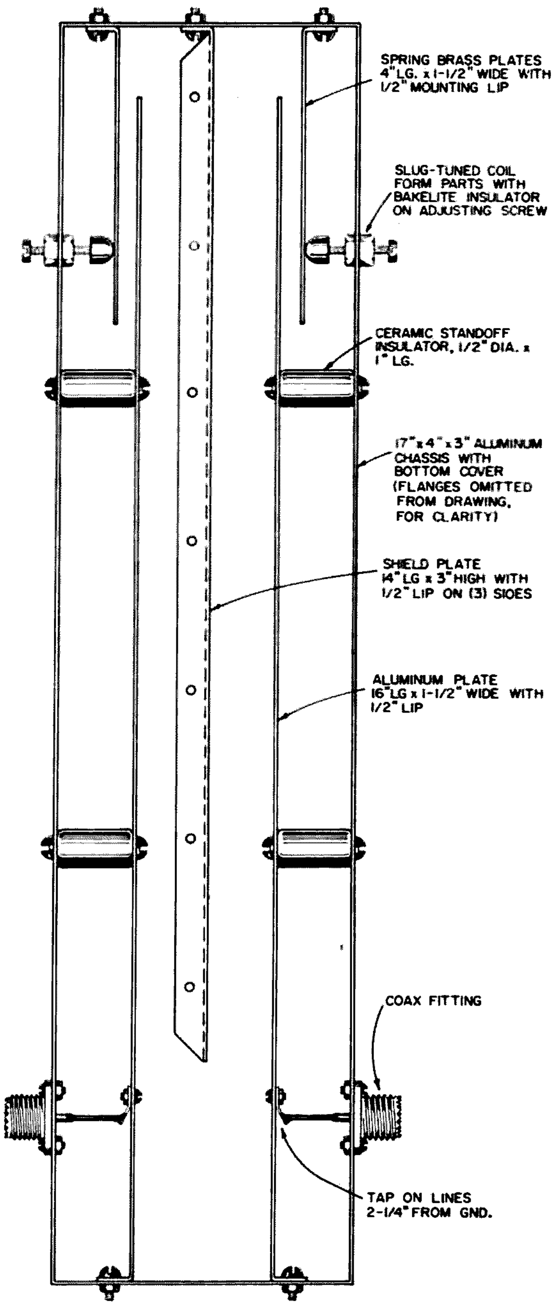
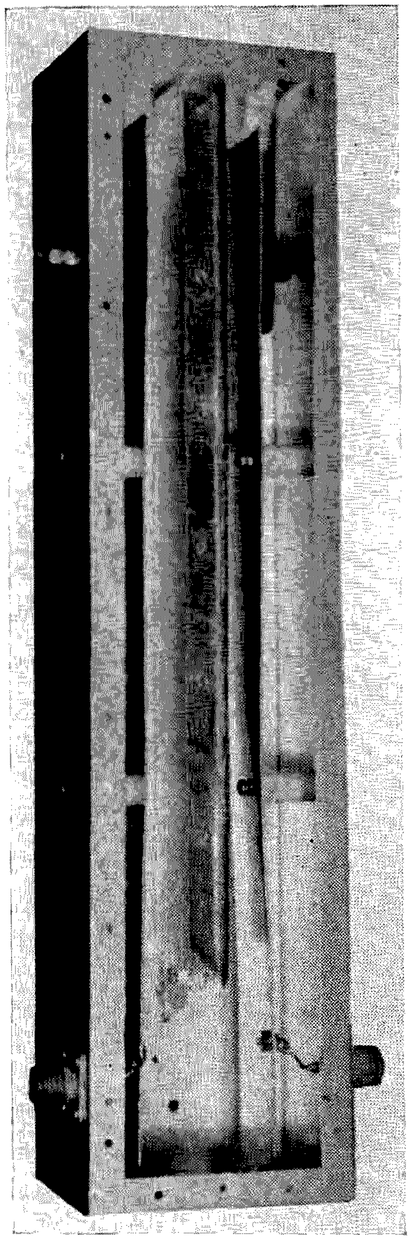


Fig. 1. Two meter antenna coupler-filter. This drawing is one-third size.

at the "hot" ends consists of pieces of spring brass 4.5 x 1.5 inches in size with .5 inch grounding lips. All grounding l'ps and mounting areas were sanded to get bright clean contacts and each grounding lip was fastened to the chassis with three machine screws. These grounding areas must have very low resistance in order to keep the circuit losses down to a minimum. Copper lines and shield box would provide less loss than aluminum, especially if the filter had to be made more compact in size. The spring brass tuning condenser plates are adjusted by means of spare slug coil form mountings with a .5 by .5 inch bakelite insu-



Two meter antenna coupler-filter.

lator threaded onto the adjusting screw and epoxy glued to it also. These adjusting screws were mounted about 3 inches from the ends of the 17 inch chassis centered on each 3 inch side. At the opposite end, coax fittings were mounted and tapped into the rf lines 2.25 inches from the grounded ends. Lots of self tapping screws were used to ground the center shield to the chassis and to the bottom cover, and the cover to the chassis. This cover was 5 by 17 inches in order to use the extending sides for mounting the filter up on the wall above the antenna relay.

Two meter converter

The converter was built on a piece of copper clad board 2 by 6 inches in size for mounting into a 6 x 17 x 3 inch chassis along with numerous other converters and a switching panel for *if* outputs and battery connections. The chassis completes the rf shielding of each converter which is needed to prevent direct pick-up of signals in the 13.95 to 19 mc *if* range. Double shielded small coax lines to the *if* receiver also are advisable. The double copper braid on some types of coaxial line is worth while unless these shielded converters are mounted within the shielded cabinet housing the *if* receiver.

The Texas Instruments TIXMO5 transistors are marvelous rf amplifiers, mixers and oscillator-multipliers. The only problem encountered was breakage since these units had plastic housings which were brittle, and broke easily when the transistors were pushed into the large transistor sockets shown in the photographs. Later some smaller sockets were purchased which overcame this problem since they were designed for TO-18 sized transis-

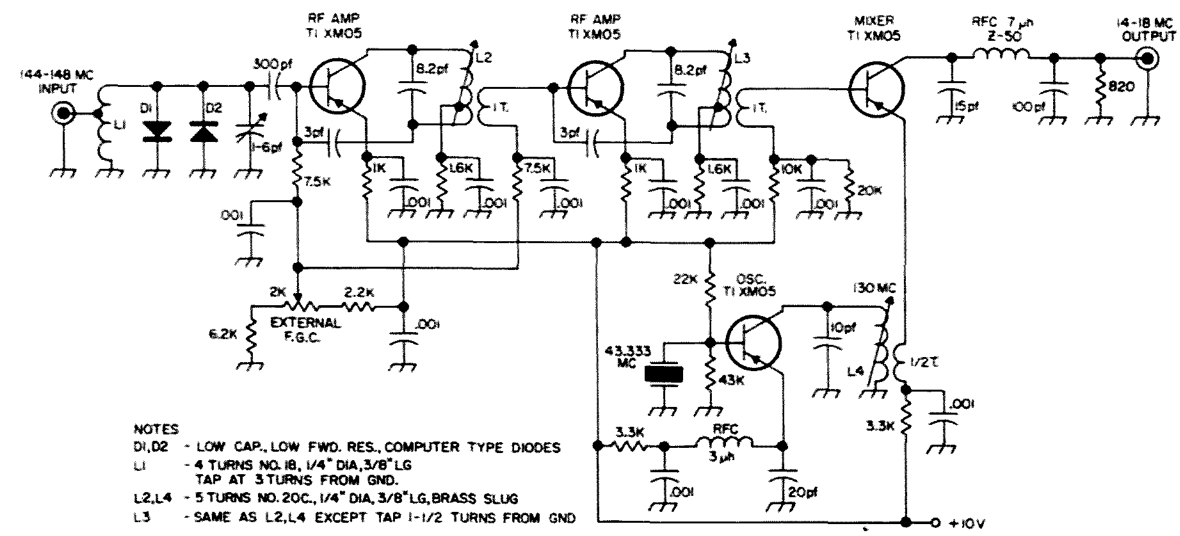
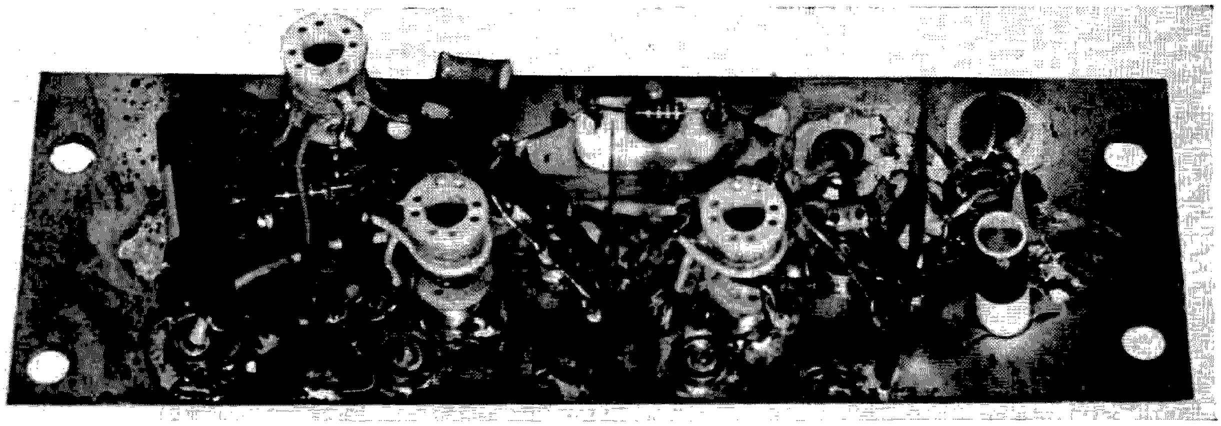


Fig. 2. Low noise two meter converter.



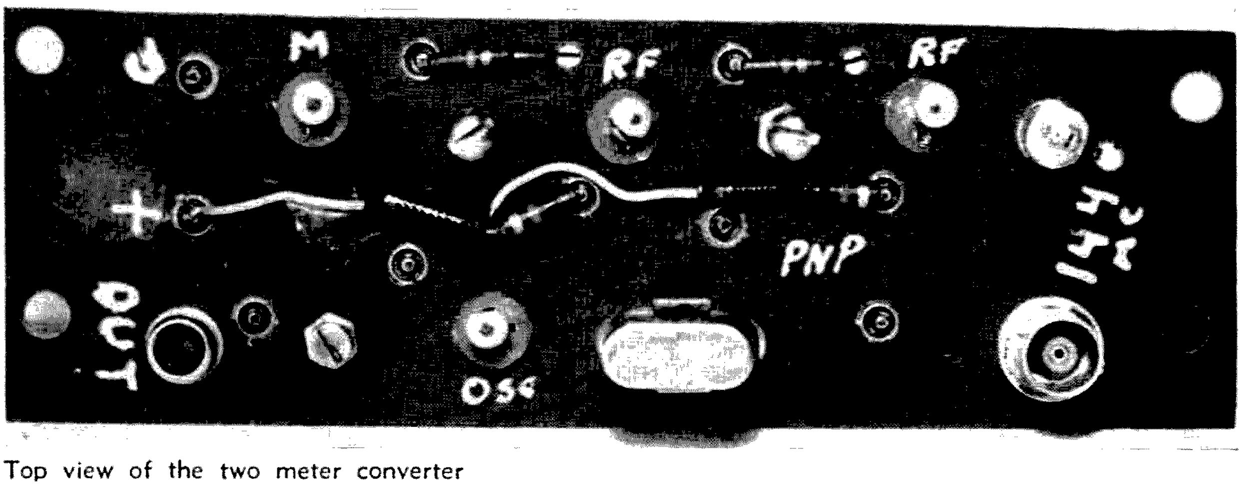
Bottom view of the two meter converter described in this article.

tors, but had the disadvantage of costing a great deal more than the TO-5 sized sockets. **Fig. 2** shows the circuit and values of parts used in the converter. White color coded ferrite slug coil forms of similar size may be used for slightly better Q values with 4 turn coils (and 1 turn taps) in place of the brass slug forms shown.

Two rf amplifiers with fixed neutralization were used with only one tuned circuit between stages since the antenna filter added a great deal of image suppression. The input circuit is a low Q (loaded) design in order to provide a low loss resistive termination to the antenna filter. This resulted in a NF of less than 2 db when a noise generator was connected directly into the coax input jack of the converter. The transistor protective back to back diodes across this input coil added about .1 db NF loss but was deemed worthwhile for protection against an antenna relay isolation deficiency when using a high powered transmitter. Low forward resistance diodes with low shunt capacitance are needed for this purpose. Type 1N100 diodes were used here, but better diodes are available. Don't use the old "standby" IN34A diodes in such a low impedance circuit such as shown in **Fig. 2.**

The mixer stage uses base input and emitter oscillator coupling with large enough bypass condenser values to give a low impedance even at the *if* frequencies. This avoids the need of series tuned (at 14 to 18 mc) circuits shunted from base and emitter to ground. The mixer collector circuit has to be of low Q design in order to cover 4 mc bandwidth. The pi network of **Fig. 2** meets this requirement and fixed values of capacitors and inductance may be used to obtain a center frequency of about 16 mc to cover from 14 to 18 mc. The values shown provide a mixer load impedance of about 2000 ohms or more, with an output impedance of 50 or 75 ohms for connection to the *if* receiver.

The 43.3333 mc overtone crystal oscillator has an emitter circuit resonant about midway between the overtone and fundamental crystal frequencies. This insures oscillation at the overtone frequency only and permits the single transistor to provide 130 mc output in the collector circuit for coupling into the mixer stage. Transistors other than TIXMO5 may require a different value of emitter con-



Top view of the two meter converter

denser than the 20 pf shown since this value regulates the regeneration at the 130 mc output frequency. Less efficient transistors require smaller values. The small 3 μh rfc in this emitter lead must resonate with the small emitter bypass (20 pf or so) at some frequency above 15 mc but below 43 mc. Resonance below 15 mc will cause the overtone crystal to oscillate at its fundamental and introduce a strong signal into the *if* receiver tuning range. If this effect is present use a smaller inductance such as an Ohmite Z144 rfc of 1.8 μh. Too small a value of capacitance from emitter to ground may cause oscillation near 130 mc not crystal controlled. Too large a value will cause less output at 130 mc than is needed for good mixer conversion gain. Too much oscillator voltage injection into the mixer is undesirable so a value of coupling link should be chosen to provide a little less than maximum mixer gain and noise. All of these adjustments interact to some extent so some experimenting is desirable if optimum results are to be obtained.

In locations where there are other two meter ham stations, an rf gain control is needed, which is external to the converter. This is a type known as forward gain control since the current in the transistor is increased to reduce the gain. This requires a collector resistor and rf bypass condenser which reduces the collector dc voltage fast enough to cause a gain reduction as the current increases. Forward gain control is many times better for overload and cross-modulation reduction as the transistor gain is reduced as compared to the more usual current reduction-gain reduction circuits used in many transistor rf and *if* designs. By the same token, forward automatic gain control (FAGC) in transistor *if* systems is highly desirable. With PNP type transistors FGC of the type shown in **Fig. 2** causes a collector current increase and gain reduction as the potentiometer is moved to a less positive voltage setting. The values of limiting (fixed resistors) and potentiometer values can be chosen to give optimum gain control for nearly any type of transistors. The total resistance across the battery supply can be of values such that the battery drain is somewhere between ¼ and 1 ma in the main control unit. The transistor base current (microampere values) is then negligible in figuring resistor values. These values should be such that the transistor collector current in each rf stage varies from about 1 ma at full gain (or lowest NF) to about 3 ma at reduced gain and 1 volt or so across the collector to emitter.

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Low noise, inexpensive, easy-to-build converters and filter for our highest VHF band

220 mc Transistor Converter

The 220 to 225 mc band in many locations is subject to strong image signal problems which can be reduced greatly by using a pair of high Q circuits in the antenna feeder. An antenna filter of this type suitable for transmitting and receiving service is shown in **Fig. 1.** It consists of two high Q circuits capacity coupled together at the tuning end of each line and loaded down to a working Q of about 25 for 50 ohm coaxial input and output lines. This loading is chosen by the position of the coax jack taps on each flat plate line near its grounded end. A tap point 1.5 inches from ground end seemed to function well over a large portion of the 220 mc band. The circuits are tuned to resonance by spring brass plates with adjustable spacing to the flat plate line at the "hot" end. The coupling capacitor is at this end also and consists of an insulated U shaped metal bracket as shown in **Fig. 1.**

The coupling depends upon the spacing at the ends so some adjustment can be made by bending the sides of the U bracket or by making a new one with more or less length between the sides of the U. Probably a better coupling scheme would be an aperture cou-

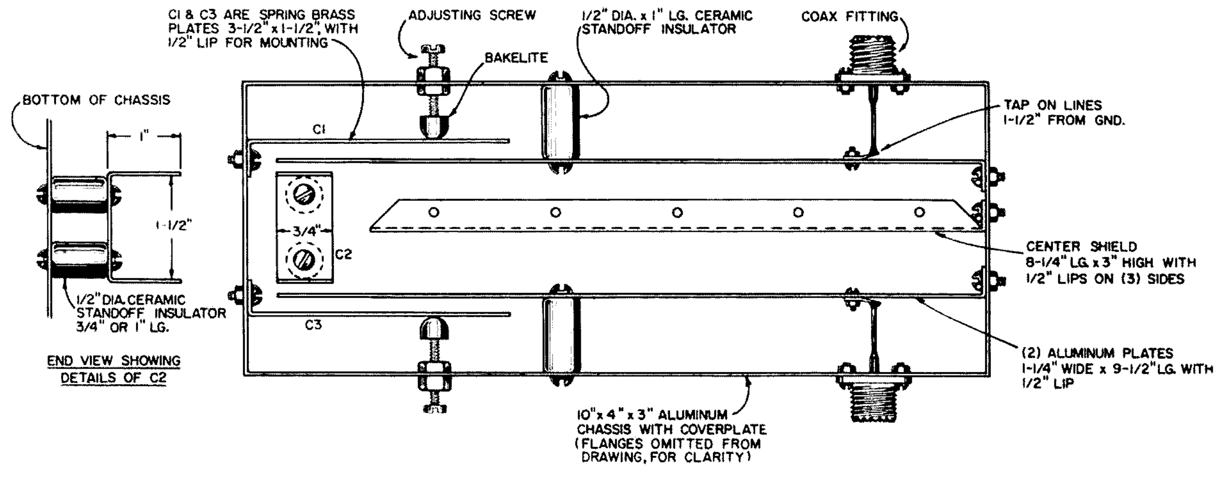
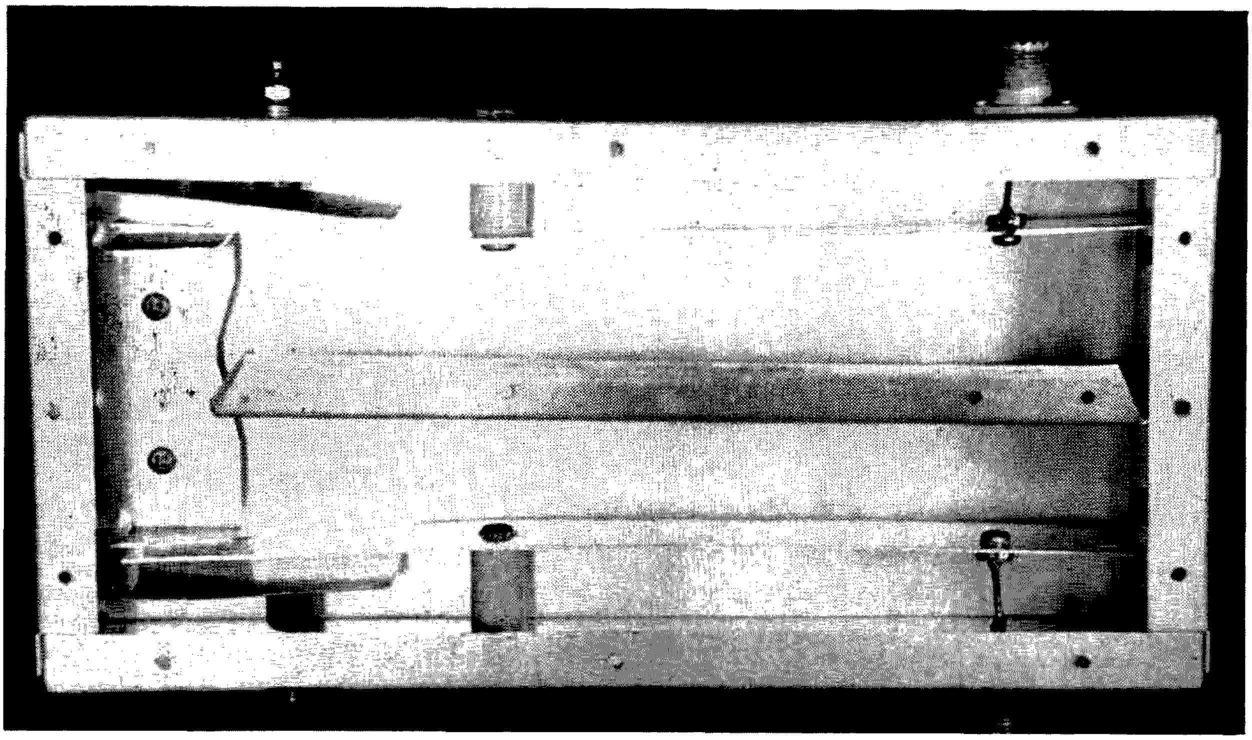


Fig. 1. 220 mc antenna coupler-filter. This drawing is one-third size.



220 mc antenna coupler and filter.

pling at the high current end of the lines as was used in the 144 mc circuit unit previously described. The center shield with both sides grounded would then be about 8 inches long, also grounded at the tuning condenser end. The aperture would be a 2 inch gap (approximately) at the coax jack end, making a total aperture opening of 2 by 3 inches in size for coupling the two lines together. This would eliminate the coupling capacitor U shaped bracket at the opposite end of the lines. An aluminum chassis, with cover, 10 x 4 x 3 inches in size encloses the flat plate lines. This with the center shield forms two air gap strip lines of high Q design, perhaps in the neighborhood of Q = 1000 unloaded. With loading and coupling, the Q is around 25 which would mean a loss of about .5 db for the complete filter. This loss would mean about half a decibel loss in NF for receiving and at the same time an efficiency in this filter of over 90% for either transmitting or receiving. The air gaps and design should make it suitable for KW operation though the heat loss might make it advisable to use copper plate lines and shields for lower losses. When the heating ef-

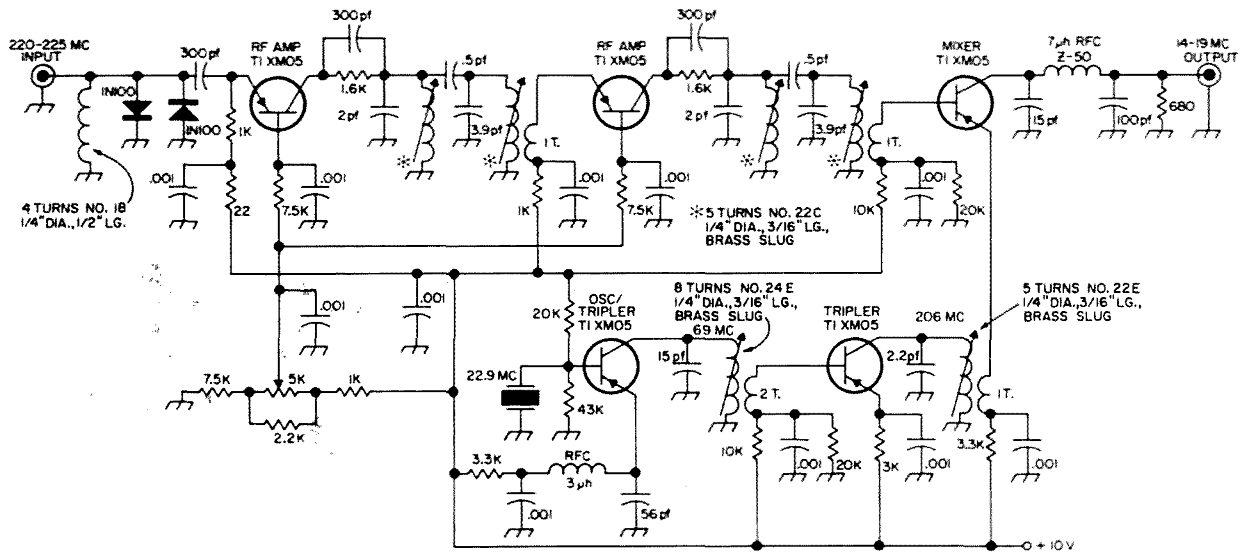
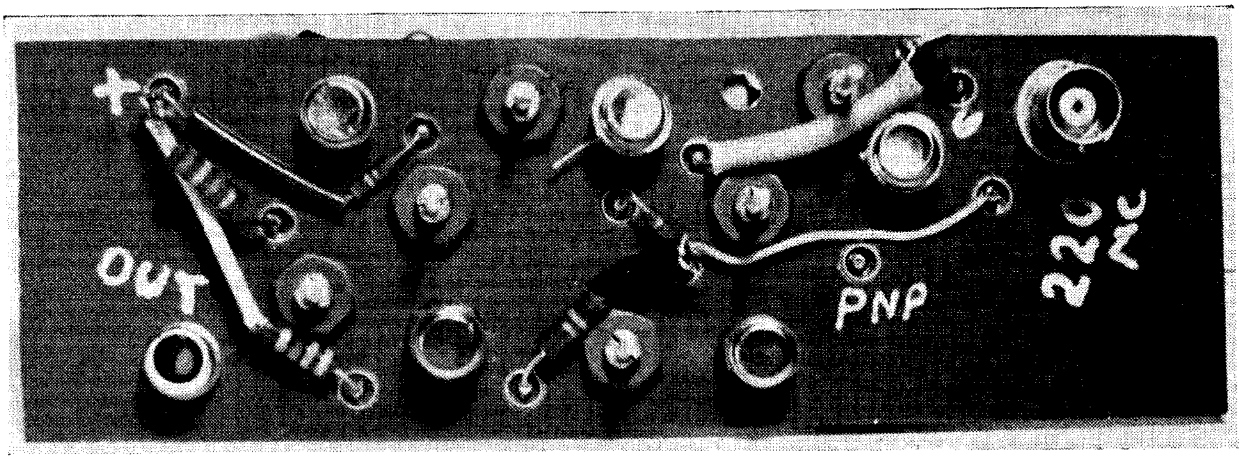


Fig. 2. 220 mc converter with common base amplifiers. This circuit is recommended for general use because of ease of adjustment and simpler construction.



Top view of the converter in Fig. 2. The large transistors were replaced by TIXMO5's for better noise figure after this picture was taken.

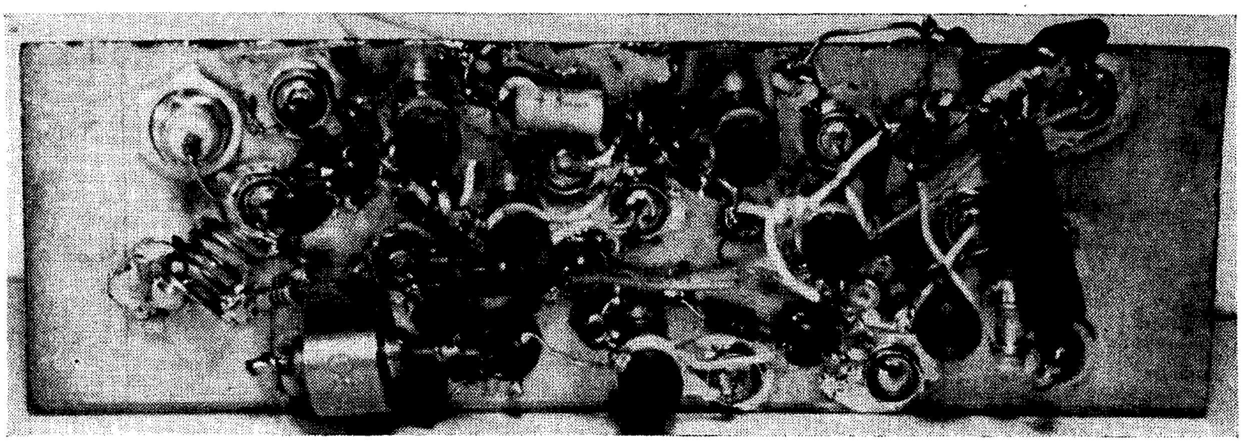
fects become readily apparent at very high power operation, the coupling and tuning capacities will change. Aperture coupling with copper or silver plated brass construction would then be indicated. The aluminum construction is suitable for antenna inputs of up to 200 watts with negligible heating effects.

220 mc converter

The new TIXMO5 transistors were used in this converter to reach a NF of about 3 db. At 220 mc, either neutralized common emitter rf stages or un-neutralized common base circuits, may be used. The former has more gain, slightly better NF, but is more complicated and uses more parts. The common base circuit was used in the unit shown in the photographs and in **Fig. 2** and is suggested for general use. One of the older 220 mc converters here was rebuilt several times and wound up with the circuit shown in **Fig. 3**. With TIXMO5 transistors, it did have a little more stable gain and a fractional db better noise figure but the "rats nest" wasn't suitable for photographing.

The circuit of **Fig. 2** consists of two grounded base rf stages, with forward gain control separate from the converter, 2 by 6 inch copper copper clad board. This control can be set for best NF, which is below the oscillation point in the rf amplifiers. This type of rf amplifier is regenerative and there is no easy way to neutralize the stages; however, a variable gain control with screw driver adjustment solved the problem. 220 mc is apparently near the upper frequency of common emitter, neutralized rf stage operation so there is little choice between the circuits shown in **Figs. 2** and **3.**

The mixer stage can be either base or emitter input for signals and the emitter or base used for oscillator injection. The input impedance at frequencies above 200 mc is not too different for base or emitter inputs. The collector circuit is broadly tuned to 16 mc with a pi network to cover 14 to 19 mc, the **if** signal range. Fixed inductance and capacities are suitable here with the 15 pf input (high Z end) the only critical value. With other transistor types having higher output capacitance, a smaller value than 15 pf would be needed and an adjustable 5 to 18 pf condenser should be used.



Bottom view of the converter shown in Fig. 2. The drum shaped object in the lower left is the crystal.

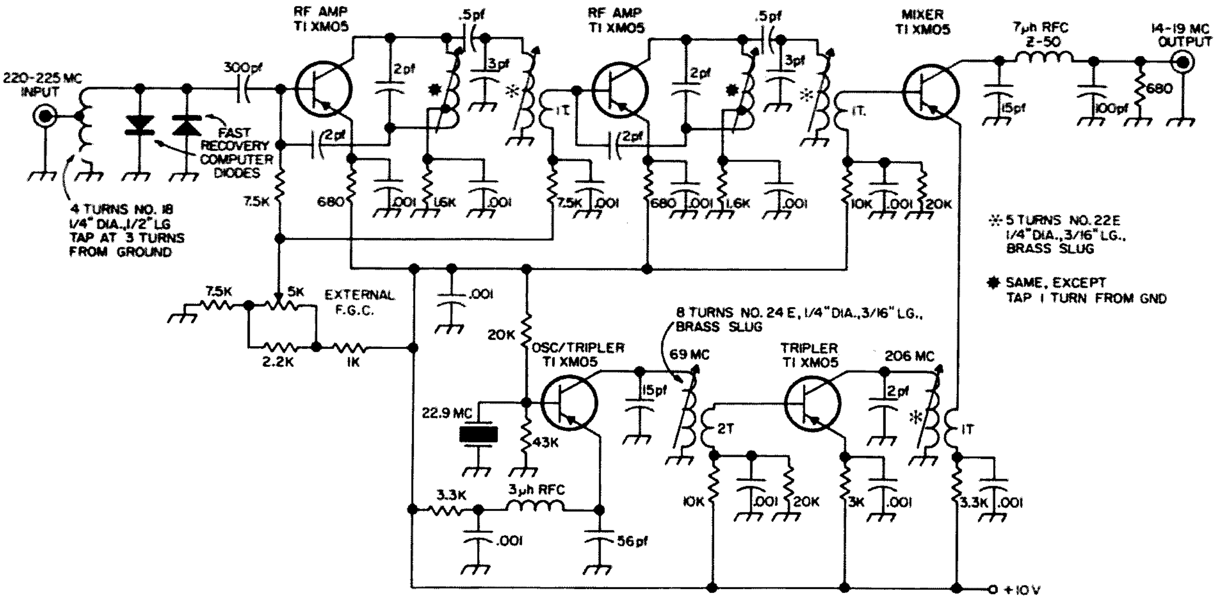


Fig. 3. 220 mc converter with neutralized common emitter amplifier stages. This converter gives a better noise figure and higher gain than the converter in Fig. 2, but is harder to adjust.

The oscillator multiplier chain has two transistors, one as an oscillator-tripler and the other as a tripler to obtain 206 mc output from a 22.889 (or 22.9) mc overtone crystal. The emitter circuit is resonant between 22.9 mc the third overtone, and 7.6 mc the fundamental frequency of the crystal. This prevents 7.6 mc oscillation and causes 22.9 mc oscillation at the third overtone frequency. In turn this is multiplied by three times to approximately 69 mc in the collector circuit. The 56 pf condenser in the emitter produces regeneration at the output frequency, resulting in good output to drive the second transistor tripler stage to 206 mc. This 206 mc power is coupled into the mixer emitter for mixing the 220 to 225 mc signals down to 14 to 19 mc, the output signal from the converter. The pi network transforms the high impedance of the mixer collector down to 50 or 75 ohms coaxial line output for connection to a receiver tuning the 14 to 19 mc range.

The input transistor is protected from overload by two diodes across the self resonant coil input circuit. These diodes were IN100 diodes which are not as good as fast computer diodes for this purpose but do a fair job since they are low forward resistance types suitable for VHF work. If better diodes of low shunt capacitance (at zero bias) are available, use them since transistors have much longer, low NF, life when not overloaded by transmitter signals leaking thru the coaxial antenna relay. As the operating frequency is increased, antenna relays are less effective in isolating the receiver from the transmitter. Very fast silicon type computer diodes generally have low enough capacitance to work as protective devices up to above 432 mc. A few germanium diodes rated for VHF with at least a 20 ma at +1 volt rating are fairly good at 220 mc.

A signal generator and noise generator are both desirable for use in aligning the converter for best weak signal reception and best NF. Oscillator operation can be roughly checked by listening to the hiss level in the if receiver when shorting out the oscillator or tripler tuned collector coils. The mixer noise in the receiver should be louder when the crystal oscillator is functioning. Too great an increase of noise may indicate excessive oscillator injection into the mixer or "blocking" type of oscillation in the crystal stage. The input coil turn spacing or even the number of turns may need adjustment for best NF and weak signal reception. Some protective diodes have greater or less zero bias shunt capacitance, which would mean that the input coil must be adjusted so it resonates at or near the low end of the 220 mc band. The transistor loading makes it very hard to "grid dip" adjust this circuit, so a noise generator is of great help at this point. The interstage slug tuned coils and the "gimmick" coupling condensers (a twist or two of plastic covered 24 or 26 wire) can be adjusted for maximum gain and best coverage of 220 to 225 mc. In case the converter is to be used mainly at some spot frequency such as 222 mc, the coupling condensers between tuned circuits can be of very small capacitance and all tuned circuits peaked up at that spot in the band. . . . W6AJF

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You'd be hard put to find a simpler, cheaper way to receive 432 mc than this excellent low noise converter.

432 mc Transistor Converter

The new Texas Instrument TIXMO5 transistors were rated for operation at 200 mc but are surprisingly good at 432 mc. These units compare very favorably with transistors costing many times as much, and at about 50 cents apiece, a few extra can be bought in order to get some very choice ones for the front end of a 432 mc converter. The writer found that about one out of every three were red hot for 432 mc operation and the other two out of three were still better than other $3.00 types generally used at 432 mc. The only problem in their use is mechanical breakage of these plastic cased units. This can be minimized by using the new transistor sockets made for type TO-18 cased transistors since the three leads do not have to be spread out as when using the larger (TO-5 type) sockets. The writer managed to break a few transistors in the first converter built here so a new one, shown in the photographs, was built with the new smaller sockets. No more breakage was encountered but it is a little upsetting to pay as much for a socket as for a transistor. Direct soldering of the transistors into the circuit might be an alternative but makes it hard to select the lower NF transistor for the first rf stage. This arrangement was used finally in the first converter in place of the large sockets though one transistor was damaged in the process of soldering. The small but expensive sockets are really the best solution.

432 mc antenna filter

In **Fig. 1**, a dual circuit antenna filter is shown which was built into an aluminum chassis box 12 x 2¼ x 2½ inches in size. This unit works reasonably well for receiving and for transmitting at low power perhaps up to 50 watts output. With a pair of 4CX250R tubes in the final amplifier, the aluminum box gets hot at the low impedance ends and circuits go out of resonance. The circuits would stay in resonance for a minute or so with 400 to 500 watts of rf power then the box gets warm to the touch and losses go up as the circuits go out of resonance and dielectric losses also increase. Then end result was retirement of this antenna filter to the receiver front end only since its losses, when cold, are approximately one db. The signal loss then is not too objectionable for normal 432 mc signal recep-

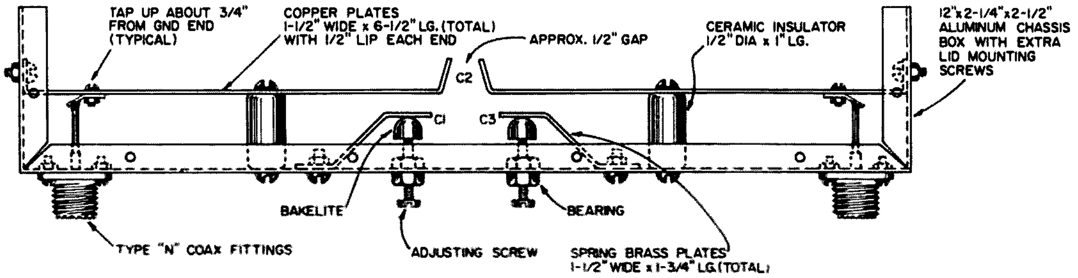
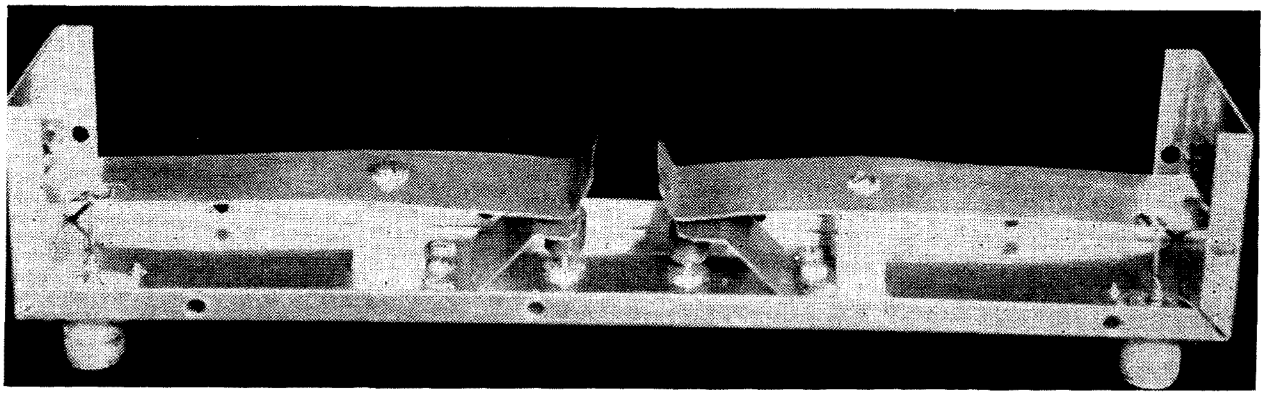


Fig. 1. 432 mc antenna coupler-filter suitable for receiving and low power transmitting use.



432 mc antenna coupler-filter.

tion. The next project at W6AJF will probably be a heavy duty dual coaxial circuit unit built of copper since the writer likes to use high power at 432 mc occasionally. The filter in the transmitter output is highly desirable to nearly eliminate lower and higher order frequencies from getting into the big antenna array. More TVI problems have been encountered here on 432 mc than on 220 or 144 mc band operation, so a good antenna filter is needed. Solid state stereo phonographs and FM band receivers increase the "TVI" problem for many amateur VHF operators.

432 mc converter

At 432 mc, common base rf stages are usually much easier to get into proper operation than with neutralized common emitter systems. The converter shown in **Fig. 2** and in the photographs uses two common base rf stages with forward gain control to set the gain just below oscillation or high regeneration operation. The advantages of forward gain control have been discussed in previous sections on transistor converters. The mixer stage seemed to function best with signal and oscillator injection into the base circuit. Emitter injection was tried but resulted in mixer oscillation due to the added inductance in the emitter lead at 432 mc. The mixer output circuit in **Fig. 2** is a simple tuned circuit since only about .5 mc bandwidth was needed near 14 mc, the **if** output. If wider frequency coverage is desired, the pi network used in the 144 mc converter, previously illustrated, will cover 4 or 5 mc but with somewhat less mixer gain.

The oscillator uses a 46.444 or a 139.333 overtone crystal with the collector circuit tuned at or near 139.3 mc. The emitter bypass condenser, a small 5 to 25 pf adjustable condenser, permits either type of crystal to be used. It is set for best oscillation in either case. The coupling condenser to the "fast" diode tripler was made adjustable in order to achieve optimum load on the oscillator and maximum output from the diode tripler stage. The 1N914 is a fairly low capacitance high speed computer diode (silicon type) which is better than a 1N82A as a frequency doubler or tripler to 418 mc. It is also suitable for use as back to back protective diodes in the front rf

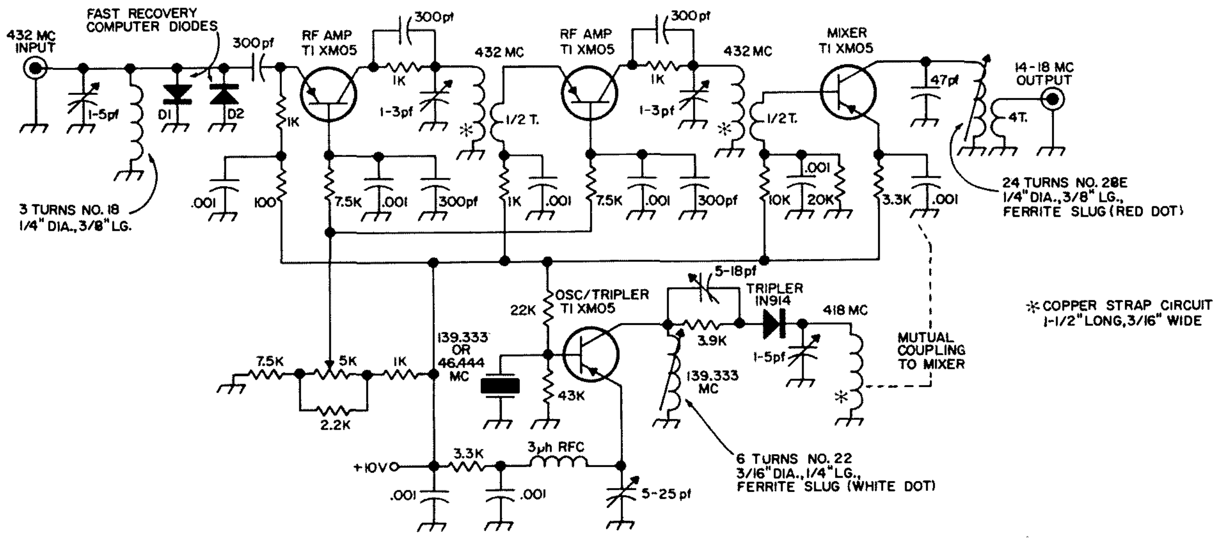
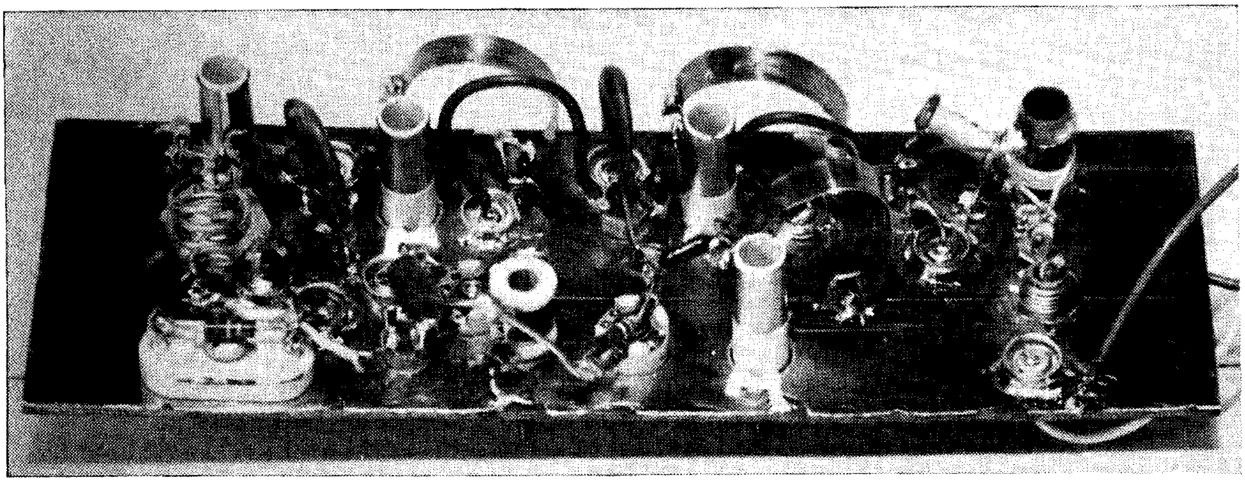


Fig. 2. 432 mc low noise converter using 50¢ TIXMO5 transistors.

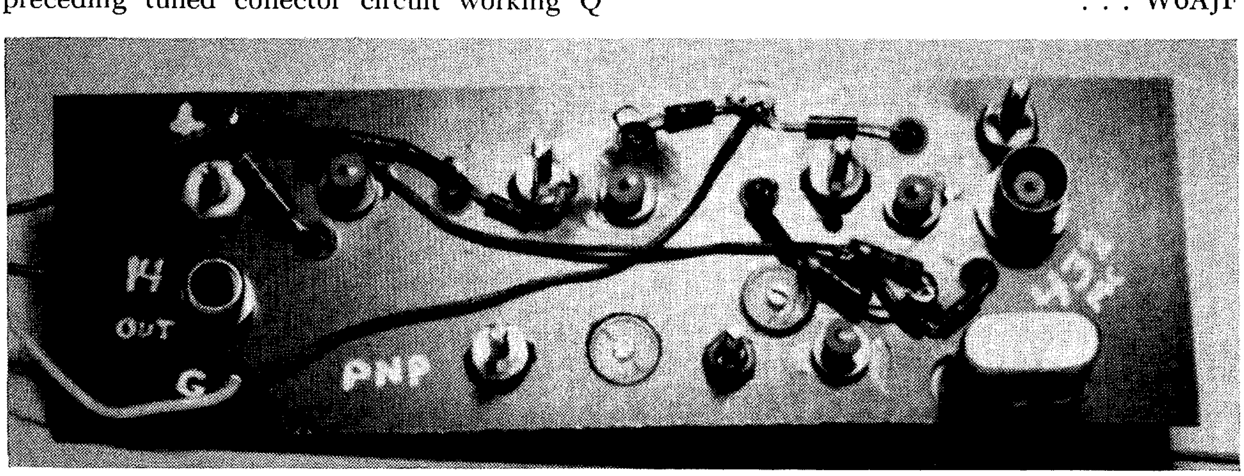


Bottom of the 432 mc converter.

stage though the 4 pf shunt capacitance per diode means some coil turn juggling to keep the input tuned to 432 mc. Type 1N100 diodes were used in the unit shown here since they seemed to have less shunt capacitance and antenna relay leakage from the transmitter wasn't too severe at W6AJF. The coax relay was a hard to find type more suitable for operation in the UHF region than the standard Dow relays available for lower frequency operation at W6AJF. Type N fittings are more efficient at 432 mc and the Dow relays at this station all had the other type of fittings which are suitable for the VHF bands but not as low a SWR rating at UHF.

The grounded base input rf stage has a tendency to oscillate with a change from one antenna to another or to a signal generator. A small variable condenser was shunted across the coax input jack and just enough capacitance added to stabilize this stage. The input coil still has to be adjusted for best NF with a noise generator. The second rf stage will likewise oscillate if the emitter coupling coil is too far away from the 432 tuned copper strap circuit. Too loose coupling will also make the preceding tuned collector circuit working Q value too high and tend to make the converter tune too sharply and be too regenerative. The rf gain control will not function properly if the two rf stages are not loaded correctly and are excessively regenerative. Any 432 mc converter takes a little time and care in adjustment for best weak signal reception. When you get a 432 mc converter into such good operation that occasional auto ignition noise is very noticeable it is probably red hot for 432 operation. It takes a 432 paramp to do better on 432 weak signals. The measured NF of this converter was 4 db which is better than any other transistor converter (except an expensive 2N2857 unit) tested here. It was definitely superior to grounded grid nuvistor and 416B converters tested here on the same noise generator. It would seem that solid state devices are really here to stay. The 4dbNF measured here after a long period of adjustments, is a relative figure since some other noise generator might read a 2 or 3 or 5 db figure. Noise measurements above 200 mc can be very individualistic but are still useful in getting the best NF possible from a converter in the UHF region.

. . . W6AJF



Top of the low noise 432 mc converter described in this article.

Information on standard frequencies around the world. Don't miss the practical construction article on VLF receivers coming up in 73.

Standard Time and Frequency Transmissions

Sam Kelly W6JTT
12811 Owen Street
Garden Grove, California

WWV is the first station that comes to mind when a ham thinks of a standard time and frequency station. Actually, WWV and WWVH, which are operated by the National Bureau of Standards (NBS), comprise only a few of the world wide standard time and frequency stations which may be of interest to amateurs. **Table 1** lists world wide stations which are classed as "standards" by the International Radio Consultative Committee (CCIR). As you can see, they range in frequency from 14.7 kHz to 25 MHz. Many of them in the high frequency range share the same frequency with other stations, (notably WWV and WWVH) which is why they are difficult to receive in the U.S.

NBS

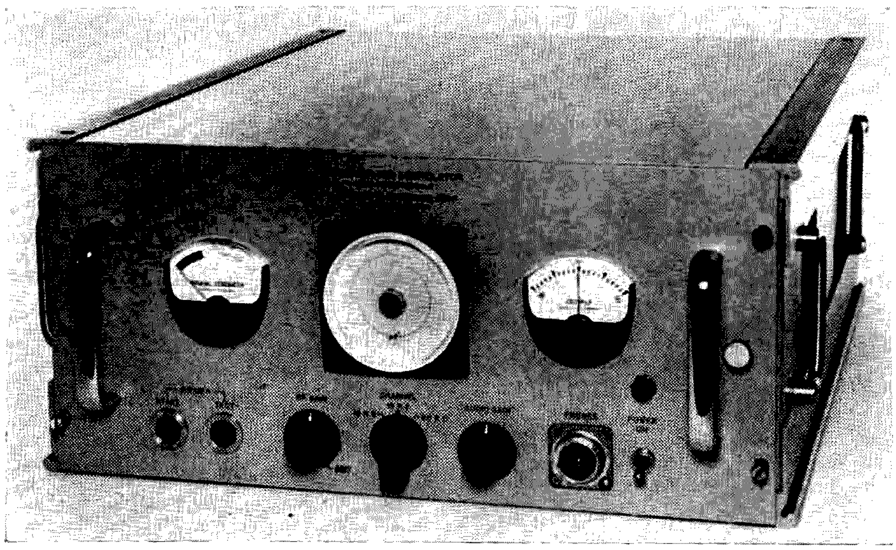
The high frequency services of WWV and WWVH are of most importance to U.S. amateurs. We are all aware of their usefulness for time and frequency spot checks. Actually there are eight technical services provided by HF NBS stations. The services of most interest to Hams are the standard audio and radio frequencies, time announcements, propagation forecasts and geophysical alerts.

Standard audio frequencies of 440 and 600 Hz are broadcast by WWV and WWVH. The 440 Hz note is the standard A above middle C for the music industry. The audio frequencies are transmitted alternatively at five minute intervals starting with the 600 Hz tone on the hour. The first tone period transmitted by WWV is three minutes long, with the remaining periods being two minutes in length.

All WWVH tone periods are three minutes in length. The pulse or "Tick" consists of five cycles of 1000 Hz tone from WWV and six cycles of 1200 Hz tone from WWVH.

Carrier stability is maintained within five parts in 10^{11} (which amounts to an error of 0.00005 Hz on the 25 MHz carrier). The transmitter's oscillator is correlated with the Cesium standard at NBS.

Propagation notices are transmitted during



A typical VLF receiver and correlator for submarine installation. This unit is built by Interstate Electronics for use on nuclear submarines. The receiver electronically compares a precision standard oscillator in the missile instrumentation timing system with the VLF signal. Accuracies of three parts in 10 billion are easily obtained in a few hours of observation.

the last half of every fifth minute of each hour. The forecast is transmitted in MCW. The following scale is used.

1 Useless
2 Very Poor
3 Poor
4 Poor to Fair
5 Fair
6 Fair to Good
7 Good
8 Very Good
9 Excellent

Signals classed between 1 and 4 are called "disturbed" (W), 5 is "unsettled" (U) and 6 through 9 are "normal" (N). A forecast consists of a letter and a number. The letter designates current propagation conditions while the number is the forecast for the next six hours. An example would be U 7. This would mean that current conditions are unsettled, but that they are expected to improve to "good" within the next six hours.

During the International Geophysical Year (1957-58) a series of geophysical alert symbols was established to provide a world wide warning system for events of geophysical significance. The following symbols are used:

C Cosmic ray event
E No alert
M Magnetic storm
N Magnetic quiet
Q Solar quiet
S Solar activity
W Stratospheric warning

These signals are transmitted in code 19 minutes after the hour from WWV and 49 minutes after the hour from WWVH.

You have probably heard a "burring" sound while listening to WWV. This is a special time code transmission of Universal Time (UT). It is broadcast for a one minute period ten times an hour only on WWV. The main use of this code is for standardizing time at observatories and missile test ranges. The code consist of a 100 PPS 36 bit serial pulse train containing day of year, hour, minute and second. To record this time signal you need an oscillograph recorder connected to the output of your receiver. A detailed description of the code, and the various high frequency services, is contained in National Bureau of Standards Miscellaneous publication 236 which is available from the Superintendent of Documents.

Foreign standard transmissions

Foreign standard transmissions aren't well known in the U.S. Many of them in the HF range share frequencies with WWV and WWVH. They are plagued with illegal transmissions on their frequencies just as we are in our ham bands. An effort is being made to get all governments to cooperate in closing down the bootleggers.

FREQUENCY	CALL	LOCATION
14.7 kHz	NAA	CUTLER, MAINE
16 kHz	GBR	RUGBY, ENGLAND
18 kHz	NBA	CANAL ZONE
18.6 kHz	NPG	JIM CREEK, WASH.
19.8 kHz	NPM	LUALUALEI, HAWAII
20 kHz	WWVL	FT. COLLINS, COLO.
22.3 kHz	NSS	ANNAPOLIS, MD.
50 kHz	OMA	PODEBRADY, CZECH.
60 kHz	WWVB	FT. COLLINS, COLO.
77.5 kHz	DCF 77	MAINFLINGEN, GERMANY
100 kHz	RGS	MOSCOW, USSR
200 kHz	—	DROITWICH, UK
200 kHz	RW 166	ANGARSK, USSR
1 MHz	SAZ	ENKOPING, SWEDEN
1.5 MHz	—	STOCKHOLM, SWEDEN
2.5 MHz	FFH	PARIS, FRANCE
	JJY	TOKYO, JAPAN
	MSF	RUGBY, ENGLAND
	OMA	PRAGUE, CZECH.
	WWV	GREENBELT, MD.
	ZLFS	LOWER HUTT, NEW ZEALAND
3.330 MHz	CHU	OTTAWA, CANADA
5 MHz	BPV	SHANGHAI, CHINA
	HBN	NEUCHATEL, SWITZERLAND
	IAM	ROME, ITALY
	IBF	TORINO, ITALY
	JJY	
	LOL	BUENOS AIRES, ARGENTINA
	MSF	
	RWM	MOSCOW, USSR
	WWV	
	WWVH	MAUI, HAWAII
	ZUO	JOHANNESBURG, SOUTH AFRICA
	ZUO	OLIFANTSFORTEIN, SOUTH AFRICA
7.335 MHz	CHU	
10 MHz	ATA	NEW DELHI, INDIA
	BPV	
	JJY	
	LOL	
	MSF	
	RWM	
	WWV	
	WWVH	
	ZUO	
14.670 MHz	CHU	
15 MHz	BPV	
	JJY	
	LOL	
	RWM	
	WWV	
	WWVH	
20 MHz	WWV	
25 MHz	WWV	

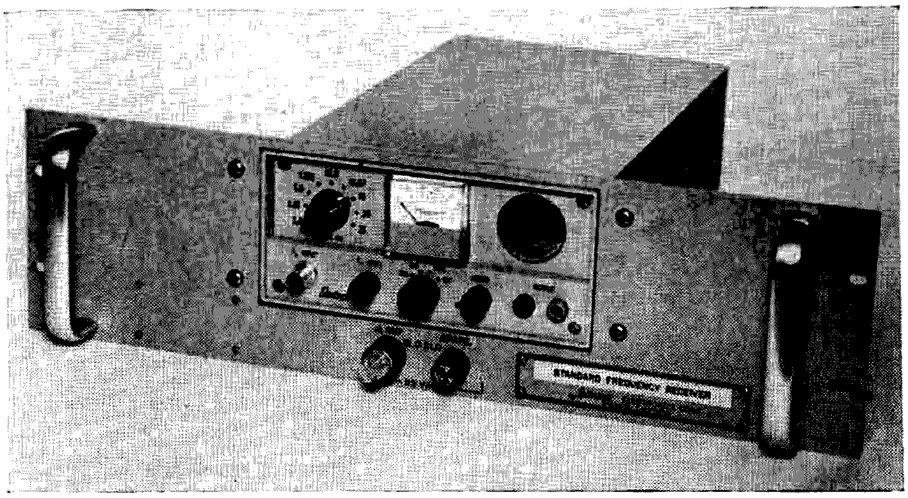
Table 1. International time and frequency stations.

Table 2 is a list of hourly modulation schedules for the most prominent foreign stations.

VLF transmissions

The high frequency transmissions are more than accurate enough for ham use. However, due to propagation instabilities they are not good enough for today's missile work.

In order to achieve a frequency of one part in 10^{10} it was necessary to average HF transmissions for a period of weeks. Now, using VLF transmissions, it is possible to achieve this accuracy in a single day's observation—anywhere in the world! This is due to the fact that the VLF transmissions follow the curvature of the earth as if the surface of the

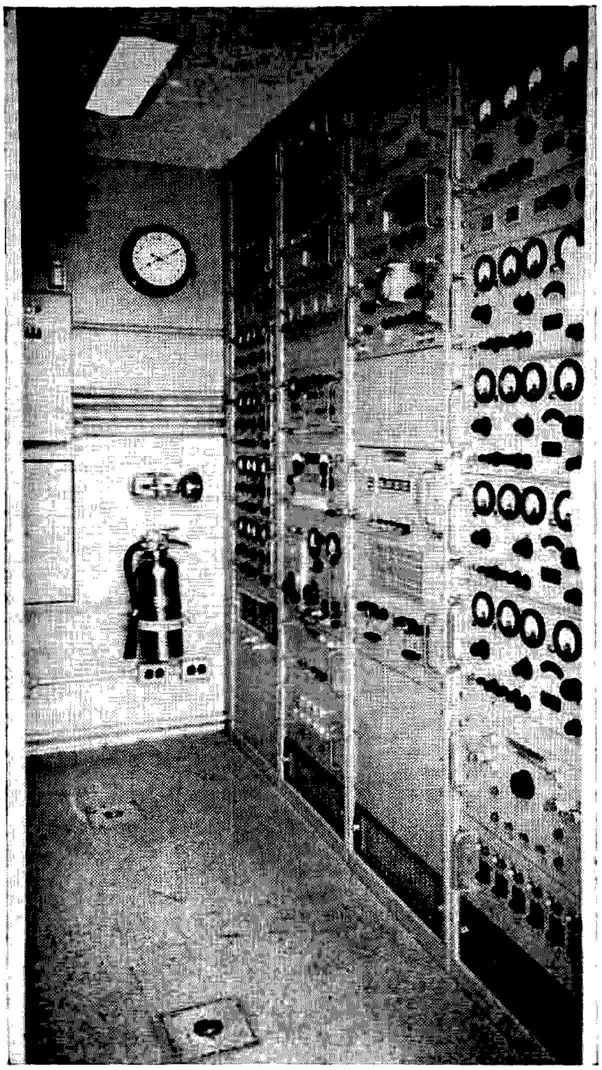


A typical standard frequency receiver manufactured by Gertsch. It is fully transistorized and receives the Canadian CHU signals in addition to WWV/WWVH. Audio frequency filters are provided for 440, 600 and 1000 Hz tones. Provision is included for oscilloscope monitoring of beat frequencies.

earth and the Ionosphere form a gigantic waveguide.

VLF has an added strategic advantage in that it penetrates water and can be received by submarines while they are submerged. Several of the VLF stations in **Table 1** (Those with a "N" prefix) are primarily for world wide communications with submarines. Due to their low frequency they are somewhat immune to ionospheric disturbances, and due to their high power relatively free from jamming. Their frequency is precisely controlled and correlated with the United States Frequency Standard (USFS).

. . . W6JTT



Gertsch Standard Frequency Receiver installed in a missile tracking van.

Call	Signal Format
ATA	Pulse or tick consists of five cycles of 1000 Hz tone, lengthening to 100 ms at the beginning of each minute. Call sign and time in MCW every quarter hour.
FFH	Pulse consists of five cycles of 1000 Hz tone. Minute pulse lengthened to 100 ms followed by 200 ms of 440 Hz tone. Announcement in MCW every 20 minutes with a five minute silent period between the 20 and 25 minute.
HBN	Carrier interrupted five times per second for 1 ms. Call sign in CW at 5, 15, 25, 35 and 45 minutes past the hour.
IAM	Pulse of five cycles of 1000 Hz tone repeated four times at the minute. Call sign in MCW and voice identification every fifteen minutes.
IBF	Pulse of five cycles of 1000 Hz tone repeated 7 times at minute. 1000 Hz tone from 5 to 10 minutes. Silent period from 30 to 50 minutes. Call sign in MCW at 10, 20 and 30 minutes. Voice identification at half hour.
JJY	1000 Hz tone with second pulses throughout hour except for silent period from 30 to 40 minutes. Announcement in MCW (includes propogation notice) and voice identification every five minutes.
LOL	Alternating 1000 and 440 Hz tones for five minute periods with voice and CW announcements every five minutes. Second pulses transmitted between 55 and 60 minutes.
MSF	Alternating five minute periods with first period consisting of second pulses, second period no emission. Announcement in morse and voice every 10 minutes.
OMA	Five minute period of 1000 Hz tone on hour, 15, 30, and 45 minutes. Carrier only from 20 to 25 minutes. Call in morse every 15 minutes.
ZUO	Second pulses of five cycles of 1000 Hz tone from 0 to 15 minutes. No emission from 15 to 25 minutes. Second pulses resume at 25 minutes. MCW announcement every 15 minutes.

Table 2. Programs of miscellaneous stations.

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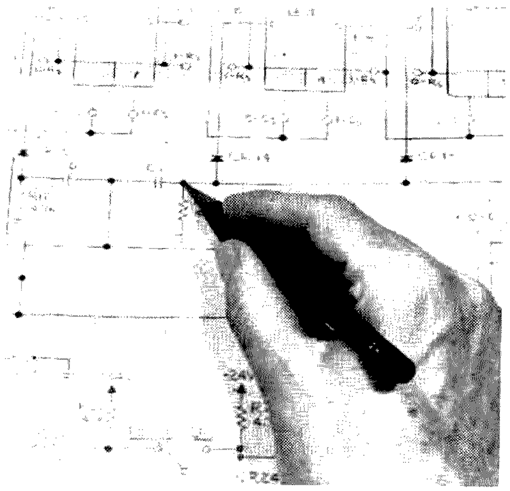

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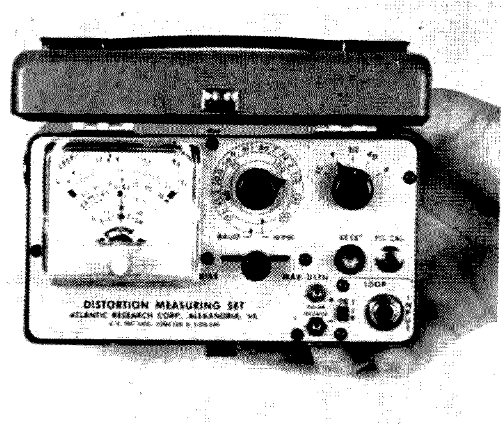
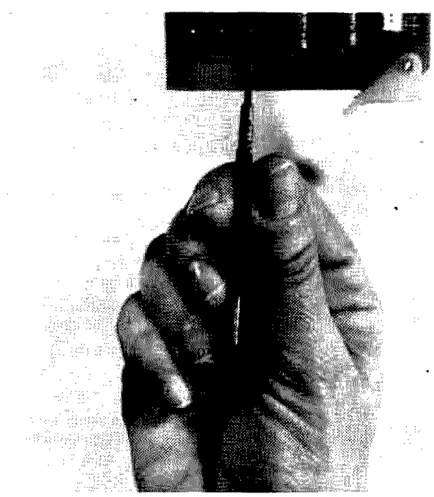


manufacture it,



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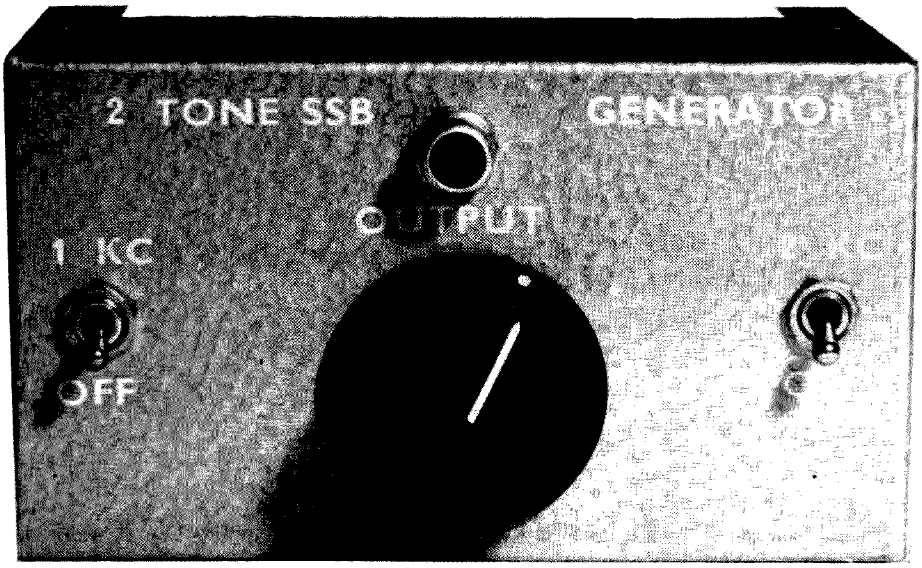


Jim Fisk WA6BSO
Peterborough, N.H.
Photos by Jim Harvey WA61AK

A Simple Two Tone Test Generator

As most single sideband enthusiasts know, the simplest and easiest way to properly adjust a linear rf amplifier is with a two-tone signal generator. With an oscilloscope and two audio frequencies about 1000 cycles apart it becomes a relatively simple task to adjust loading, drive and grid bias for maximum linearity. The transistorized two-tone generator described in this article was designed to provide the simplest possible generator which will supply the required audio signals at a minimum cost.

Two-tone audio generators that have been described in the past have used bulky inductors and capacitors in an LC circuit, but the straight-forward phase-shift circuits used in this unit maintain good stability and low distortion with two 50¢ transistors and the simplest of bias arrangements. The secret to this phase-shift oscillator's stability is the low value of collector load resistance used; this resistance effectively swamps out any changes in forward current gain that may exist between transistors of the same type. This means that the amplitude of the output signal will remain relatively constant regardless of the transistor that is used. Actually, the only requirement for the transistors is that they have high beta (h_{fe}). Many different types of PNP transistors have been tried in this circuit; some work and some don't, but both 2N2953's and 2N2613's (50¢ varieties) have been used successfully. Some of the older types—such as the 2N107—will not oscillate in this circuit because they don't have

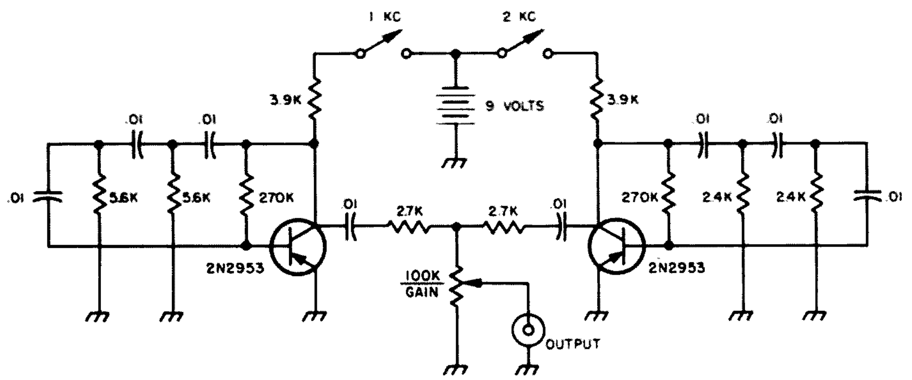


Fig. 1. Schematic of the two tone test generator.

quite enough gain. This circuit is not limited to PNP types; silicon NPN transistors like the 2N3391 work quite well if you reverse the polarity of the battery.

With a new nine volt battery, the audio output from this unit is adjustable from about five volts peak-to-peak down to several millivolts. This is more than sufficient for nearly any application requiring this type of a signal. Since the total current drain for this unit is only three milliamps, even with both oscillators going, the life of the battery is just about its normal shelf life. The output decreases accordingly, but this circuit will continue to oscillate with as little as 1½ volts applied. This means that this unit will provide a useable output even when the nine volt battery is four or five years old!

Construction and layout of the circuit is anything but critical. In the unit in the photographs, the active circuitry was laid out on a piece of Vector board (32AA18), 2 inches wide and 3½ inches long. This is quite a bit larger than necessary, but in the author's model, junk box parts were used. If one-quarter watt resistors and miniature capacitors are used, the total size could be easily cut in half. However, miniaturization can go *too* far. If an instrument of this type is made as small as physically possible, there's no room on the front panel for the switches, knob, and output jack! The 2½ X 2¼ X 4 inch LMB type J-875 Jiffy-Box seems to be a good compromise. It is small enough not to be obtrusive, but large enough so you can operate the controls. After laying the components out on the punched board and wiring them together, the whole assembly is glued to the back-end of the output potentiometer with epoxy glue. The end result is an integral, easily installed package. Granted, it's pretty tough to replace any of the components when everything is glued together, but after all, transistors last nearly forever and the other components in the circuit are operated so far below their ratings that they should last nearly as long. The battery clip is formed from thin Reynold's aluminum sheet and epoxied to the side of the Jiffy-box as shown in the photograph. The toggle switches are miniature Japanese types that are available for 29¢ apiece.

As was previously mentioned, the two-tone audio generator is especially useful when adjusting linear rf amplifiers for maximum linearity and minimum intermodulation (IM) distortion. Since the procedure for making the necessary adjustments is quite simple and has been liberally discussed in various literature*, it won't be unnecessarily recounted in this article.

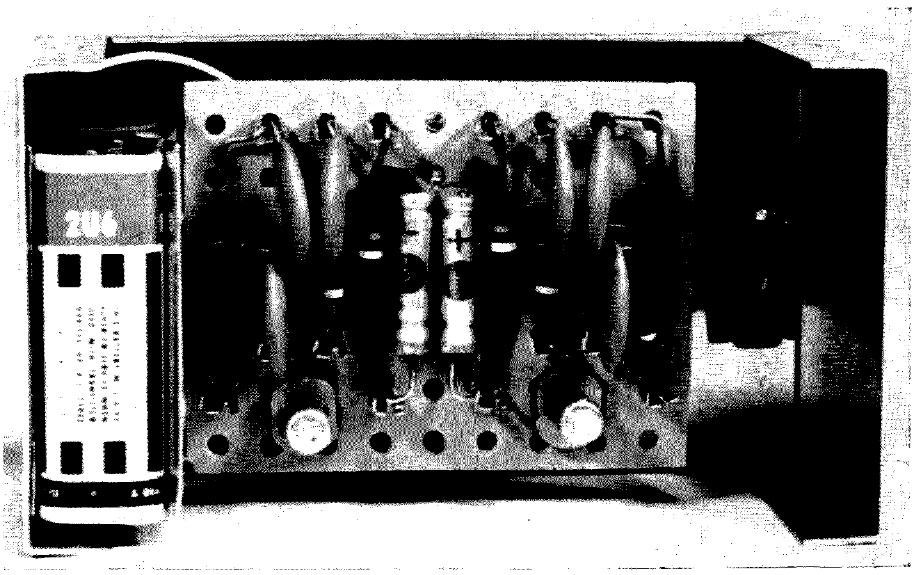
In addition to linearity adjustments and measurements, the two-tone audio generator is useful in determining the peak envelope power of an amplifier. The mathematical relation that is helpful in this respect was originally provided by Breune** and may be expressed as follows:

$$I_{pk} = I_{dc}\,(1.57 - 0.363\, I_o)$$

Where: I_{pk} = Peak plate current
I_{dc} = Plate current with two-tone signal
I_o = Zero signal plate current

* E. W. Pappenfus, *Single Sideband Principles and Circuits*, McGraw-Hill, 1964, Chapters 12 and 22.
Single Sideband for Radio Amateurs, ARRL, 1962, pp. 133-150.
Don S. Stoner, *New Sideband Handbook*, Cowan, 1958, Chapter 6.

** W. B. Breune, "Linear Power Amplifier Design," Proceedings of I. R. E., December 1956.



Inside view of the two tone test generator. Note the position of the battery bracket on the left side.

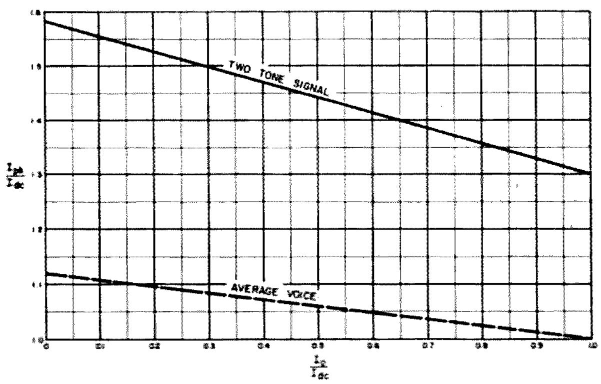


Fig. 2. Peak plate current ratings.

All this equation says is that if we know the zero signal plate current (I_0) and the plate current with the two-tone signal (I_{dc}), we can readily compute the *peak* plate current. Once the peak plate current is known, the peak envelope power may be calculated by simply multiplying the peak plate current times the voltage at the plate of the tube. The importance of the mathematics is that we are able to compute the peak plate current of the final even though we are measuring *average* values of I_{dc} and I_0. Since hams as a rule have always had a dislike for mathematics, the solid line in **Fig. 2** was plotted to show this important relationship in a straight-forward, easy to use form. It is important to point out that this solid line is the peak plate current with the two-tone audio signal and does not apply when the transmitter is modulated by a human voice. With a voice signal the peak envelope power is less than with the two-tone signal because of the lower duty cycle; the exact amount depends upon the vocal characteristics of the operator. However, experience has shown that it averages about 40% of the two-tone current. This is represented by the dotted line in **Fig. 2.**

The use of this chart requires a minimum of arithmatic yet provides the desired answer in short order. When the zero signal plate current (I_0) and two-tone plate current (I_{dc}) are known, their ratio is easily calculated by dividing I_0 by I_{dc}. This ratio is important because it determines the entry point to the chart from the lower horizontal axis. If a line is projected straight up from this entry point, it will intersect both the "Two-tone signal" and "Average voice" lines. The point of intersection determines these respective peak plate currents as indicated on the left-han axis of the chart in the form of a ratio to I_{dc}.

Perhaps the easiest way to illustrate the use of this chart and the ultimate determination of peak envelope power is through a typical example. Assume that after an amplifier has been adjusted for proper linearity, the indicated plate current with the two-tone signal is 300 ma. With the two-tone generator off the zero signal idling current is 60 ma. Therefore, the ratio I_0/I_{dc} is found by dividing 60 by 300 or 60/300 = 0.2. Entering the chart at 0.2 and projecting straight upward, an I_0/I_{dc} ratio of 0.2 corresponds to an I_{pk}/I_{dc} ratio of 1.46. The peak plate current is then 1.46 times 300 ma or 438 milliamps peak. With 2000 volts on the plate, this amplifier is running at 876 watts peak (two-tone). With the lower duty cycle of voice modulation the peak power would be about 40% of this or 350 watts. However, since the dotted line predicts the plate current with voice modulation, the voice power may be reached directly by using and dotted line of **Fig. 2** where an I_0/I_{dc} ratio of 0.2 corresponds to an I_{pk}/I_{dc} ratio (average voice) of 0.584; 300 ma times 0.584 is 175 milliamps. Power input with voice modulation then is equal to 2000 volts times 175 ma or 350 watts, the same result as before.

. . . WA6BSO

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A "Second Chance" Crystal Filter for the BC-348

The BC-348 J, N and Q series general-coverage receiver was, and is, one of the best bargains in surplus. Although it has many attractive features, its lack of selectivity is its most serious drawback. The modification described in this article converts the ol' reliable plow-horse into a sensitive thoroughbred. With the vastly increased selectivity, you'll be able to get solid copy through noise and QRM that would normally obliterate the signal.

After putting up with the problems involved in using an outboard Q-5er, we became more convinced as time went by that the crystal filter in the BC-348 ought to do more than to act as a "high-low" gain control switch. We decided to give the crystal filter a second chance and rewired it in a different configuration. The performance of the filter made a dramatic change in the selectivity of the receiver. In fact, AM phone men may find it a little too sharp for their liking. CW ops and sidebanders will find it a pure delight.

Fig. 1 shows the original circuit of the filter; **Fig. 2** shows the modified circuit. L1 is a slug-tuned coil salvaged from a BC receiver if transformer; L2 is the coil originally used in the grid circuit of the 2nd if amplifier of the BC-348. C1, C2 and C3 are "postage stamp" mica capacitors; C4 is a mica compression trimmer.

First, remove the crystal from the BC-348 for cleaning and testing. To test the crystal for activity, link-couple it to a grid-dip meter with a 15-20 turn coil and watch for a very sharp dip when tuning through 915 kc, the crystal frequency. The dip need not be great, but there must be some indication of resonance. Our first results of this test were disappointing. When we opened the crystal, we found that wax on the outside has softened and seeped inside, coating the crystal and pressure plates. After scraping the wax from the outside, carefully cleaning the crystal itself and the interior of the holder, and reassembling, it resonated very nicely.

The next step is to select for L1 a suitable inductor that can be tuned to 915 kc (the if frequency of the BC-348) and that can be mounted adequately on the chassis. We used a small 456 kc if transformer coil assembly that had two pie windings at each end. The coil

Don is an electrical engineer. His main interest is RTTY, and he thinks he was the first US amateur to operate legally in Italy after WWII. He operated from December 1945 to January 1946 from the AAF base at Capodichino on the 7000-7025 kc band.

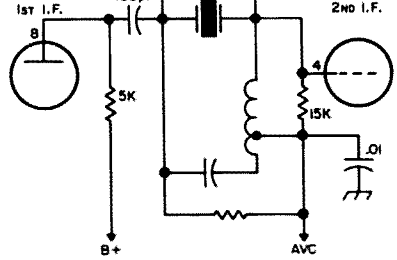


Fig. 1. Original circuit of the BC-348 crystal filter.

form, a fiber tube, was cut in half and eventually mounted by force fitting one end into a plastic cup which was, in turn, mounted to one of the unused socket ground lugs with a small self-tapping screw. Using a grid-dip meter, remove enough of the winding to resonate the coil at 915 kc with C1, C2 and C3 connected in series across it.

If desired, L2 may be left in place on the fiber mounting plate just below the crystal. However, it is not difficult to remove and is easier to work on if pulled out temporarily. Remove wires and excess solder from the terminals, then prewire 4 inch leads to the two terminals at the end nearest the mounting studs before replacing the coil. The other terminals are unused.

Remove the plate load resistor and the 100 pf coupling capacitor connected to pin 8 of the 1st if amplifier (6SK7) as well as the 35k resistor connected diagonally across the top of the fiber subchassis. Rewire the filter as shown in **Fig. 2.** The capacitors all may be lead-supported. Recheck your wiring before applying power.

To align the modified receiver, first turn the crystal switch to OUT (thus short-circuiting the crystal) and operate the power switch to MVC. Then, tune the receiver to any unused frequency and peak the tuning slug of L1 for maximum noise output from the loudspeaker. The next steps are aimed at aligning the whole if chain of the receiver to match the resonant frequency of the crystal. Operate the crystal switch to IN and turn on the BFO. Next, adjust the phasing capacitor C4 until the general background noise subsides and all that is left is a "tinny" ringing sound. Then, peak up the adjustment screws on the top and bottom of each of the if transformers, as well as L1, for maximum loudspeaker output. Repeat, as necessary, until all adjustments are peaked up. You will notice that even background noise will have a definite musical pitch as the BFO knob is swung through either side of zero beat. This completes the alignment.

Once the receiver has been modified, you'll find that more skill is needed in handling the tuning of the receiver to realize the most from the extremely sharp selectivity you now have at your fingertips. An important thing to remember is that the receiver "looks" at a very narrow slot of the frequency spectrum. The center frequency of this slot is controlled by the main tuning control—not the BFO control. Noise or signals outside this slot will not pass through the crystal and, thus, will not appear at the loudspeaker.

The secret of proper tuning, in the case of a CW signal, is simply to match the pitch of the signal to the pitch of the background noise. With the crystal filter in, adjust the BFO to one side of zero beat so that the background noise has a noticeable pitch. Then carefully tune across a CW signal. You will notice a distinct "yoop" when the signal slides into the bandpass slot. Depending on whether the BFO control is on the high or low side of zero beat, the resonance will be in the upper sideband or the lower sideband. Once you have the signal pinned down with the main tuning control, you can then adjust the BFO for a pleasing pitch. For a real surprise, tune in a weak CW signal in a crowded band. Then switch the filter out and listen to the QRM and QRN pile in. Switch the filter back in again and enjoy solid copy. The filter can be used for the reception of phone signals too. Although the audio quality is poor, the intelligibility of the signals is higher because the filter blocks out interference and noise.

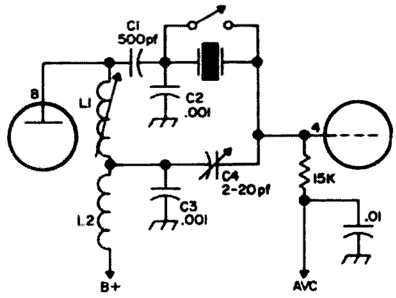
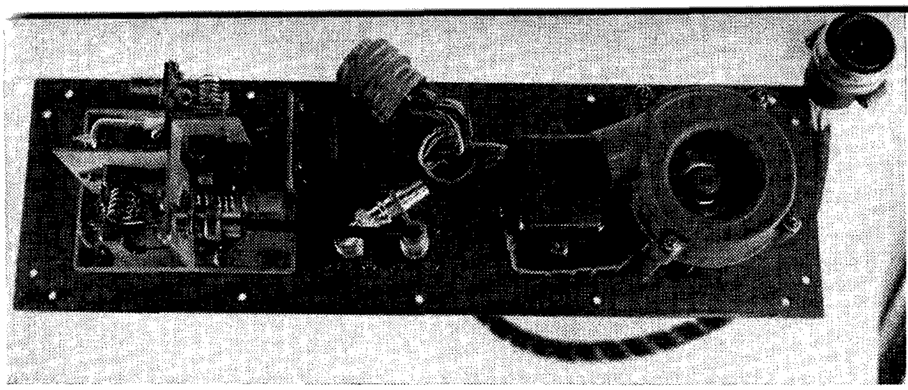


Fig. 2. Modified circuit.

The circuit is simple but very effective. Basically, it solves two problems: matching the high plate impedance of the 1st if amplifier to the low impedance of crystal circuit; and, providing a means for exactly balancing out the residual capacity of the crystal holder. L2 acts as an rf choke which is self-resonant at the if frequency. This keeps both ends of L1 "hot" to ground. The instantaneous polarity of the ends of L1 will be 180° out of phase, however, C1, C2 and C3 act as an impedance matching network as well as providing a push-pull source of signals that is balanced with respect to ground. For the moment, consider the effect when the crystal is removed from its holder. Then, with the phasing condenser adjusted to just equal the capacity of the crystal holder capacity, the "bridge" will be balanced and no signals will reach the grid of the 2nd if amplifier. That is, the signals leaking through the holder capacity will be exactly balanced out by the out-of-phase signals leaking through the phasing capacitor. Now, if the crystal is put back in its holder, it will permit only signals which coincide with its series resonant frequency to pass through and be amplified.

. . . K2ZZF



Rear of the APA-2 preamp. The blower, connectors, 6BQ7 and 416B can all be seen with the cover off.

Mel Pfeffer W5LTR
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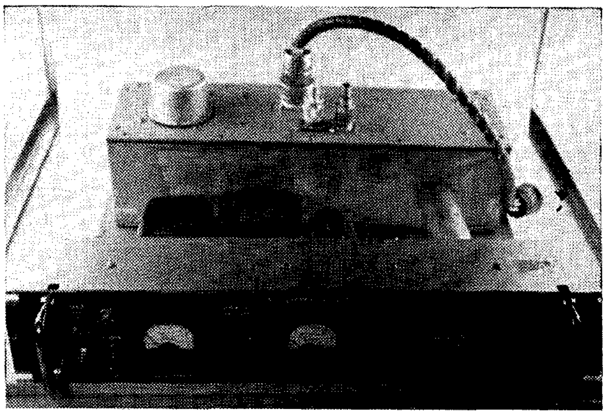
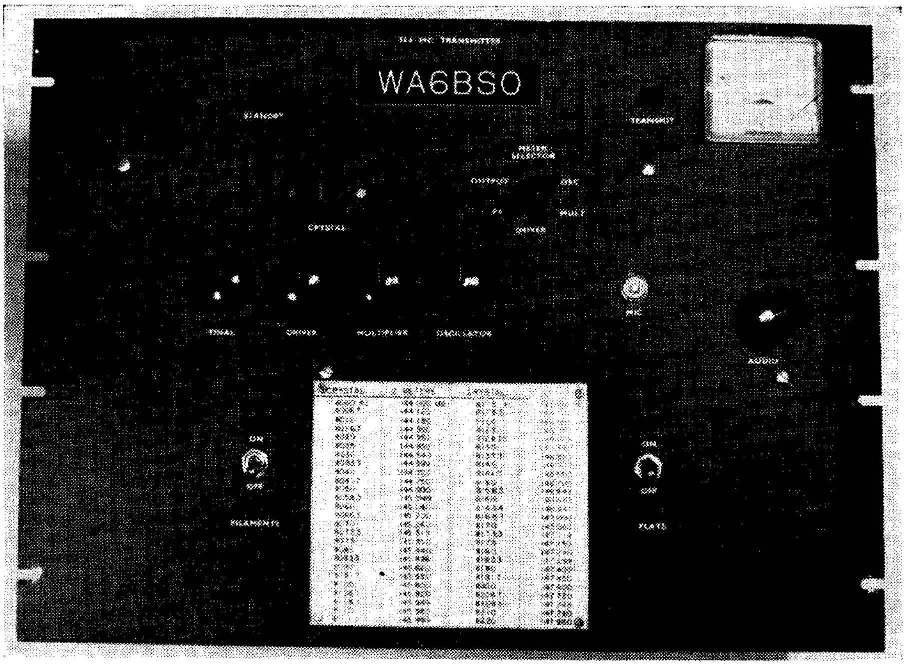
APA-2 Preamp for Two

The APA-2 preamp can be found on MARS and surplus lists and seems to be missed by a lot of VHF hams. This unit can be one of the most important components for VHF DX work. There seems to be little or no information as to its original use but has high gain and low noise for 2 meter through 432 mc. The units found locally on surplus were all manufactured by the Applied Science Corp. and ranged from 200 to 300 mc in their original form. The APA-2 consists of a power supply unit and the preamp chassis. The power supply unit is completely metered for heater voltage, plate current and plate voltage. Each circuit is adjusted on front panel for a varying voltage and current applications. Besides the ON/OFF switch there is a switch for leaving the blower on the preamp chassis running while all voltages are removed from preamp during stand by. Preamp chassis units contain a 416B and 6BQ7 follower. No modifications or changes are required in the power supply unit. The power supply is rack mounted for 19"x3½" and makes a neat panel arrangement with the pre amp unit. The connecting cable, if you were lucky to get it, can be lengthened or shortened to meet your needs in mounting. As the photo shows the preamp contains the following items: 416B with tube socket, 6BQ7, and coils in an RF box. It is cooled by a 110VAC blower and the antenna input and preamp output connection can be seen. The units here for local hams have been charged to 2 meters in the following way. The antenna input coil in the cathode of the 416B was removed and replaced with 4 turns #18 on ⅜ ID form. The coil is tapped up 2½ turns from ground and connected to an input terminal. Next the plate coil of 416B was removed. This was replaced by a ½" slug turned form. The mounting hole for the coil form had to be enlarged to hold the ½" coil form. On this is wound 5 turns of #18. One end of coil goes to the 416B plate and the other end goes to B+ for the 416B. The original circuit here is coupled to 6BQ7A by a 56 pf capacitor. I have found that if only the 416B is to be used, a two turn loop at plate end of the 416B plate coil form would couple to the output. If the 6BQ7 follower is to be used the signal is coupled by the 56 to the 6BQ7A. The plate coil of 6BQ7 is broad enough and no changes here proved necessary. The output coil at the preamp output connection is 4 turns of #18 tapped 2½ turns up from ground. The RFC chokes can be changed from Z235 to Z144. The plate coil of 416B and 6BQ7A are tuned to a band pass of 135 mc to 150 mc with a peak at 145 mc. The basic schematic is the same as shown in various VHF handbooks and no changes in values are needed. The first unit was finished and installed at W5KDT and proved its worth. With a 417A converter and 10 element 2 meter beam, signals from outside of town came up 25 db over the signal without the preamp. Signals here at W5LTR came up 23 db with Park Nuvistor convertor. The units are selling for $15.00 locally with power supply when available. Hope to hear you on two.

. . . W5LTR



Front view of the APA-2 power supply with the preamp in the rear.

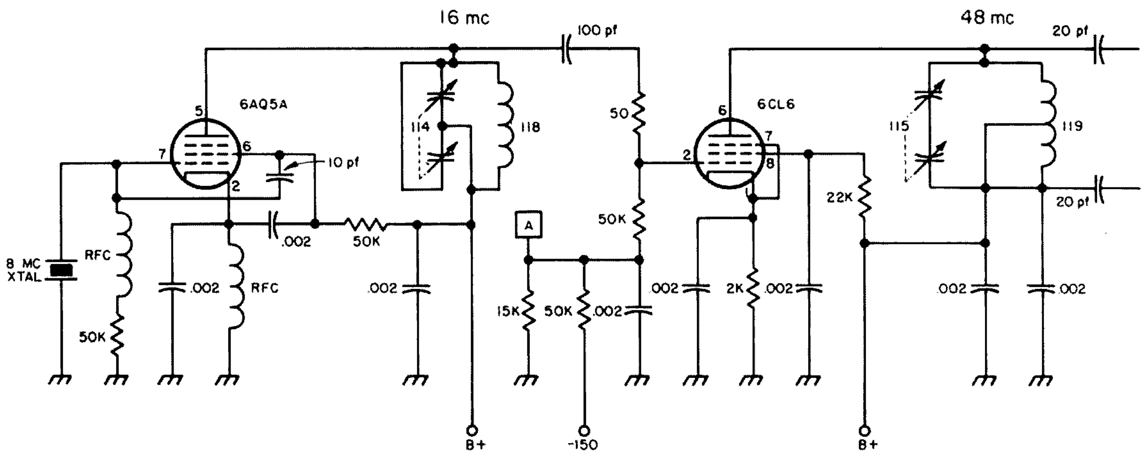


Photos by Jim Harvey WA6IAK

Jim Fisk WA6BSO
1560 Glencrest Court
San Jose, California

Modernizing the SCR-522 Transmitter

Today the easiest way to get on 432, or 1296 for that matter, is to start out with 10 or 12 watts on 2 meters and multiply up. Many different transmitters that meet these requirements have been described, but apparently the erstwhile SCR-522 has been all but forgotten. Back in the late 40's and early 50's just about everyone was using this versatile transmitter on two meters. Consequently they are plentiful, inexpensive, and when properly modified, still fulfill the requirements nicely. As to cost, the unit converted by the author was obtained from an ex-novice complete with power supply for ten dollars.



ALL RESISTORS 1 WATT, ALL CAPACITORS SILVER MICA.

Fig. 1. Revised rf circuitry for the SCR-522, replacing the old oscillator and tripler. The three digit numbers are original parts numbers.

There are probably many reasons why the old —522 lost its popularity, but TV interference was no doubt near the top of the list. We have learned a lot about TVI in the last 15 years, but many hams still tend to be afraid of the —522 because of TVI problems. In as much as this transmitter has been used nightly over a period of six months with no complaints whatsoever, these fears are apparently unfounded, at least with this modernized unit. However, considering that it was designed just prior to World War II for aircraft communications service, it is antiquated by todays standards. Fortunately it is quite easy to bring it up to date, and even in the modernized state still provides one of the cheapest ways to get on two meters.

Actually the SCR-522 is a complete receiver/transmitter, consisting of a BC-625 transmitter and a BC-624 receiver. However, for the purpose of this article we are considering only the transmitter portion of the unit. The BC-625 transmitter is a crystal controlled, plate modulated AM transmitter capable of operating anywhere between 100 and 156 m.c. These units were manufactured continuously for several years, and it is not at all unusual to find small differences from one model to another. Essentially however, the transmitter starts out with a straight-forward crystal oscillator; this circuit is controlled by an 8 mc crystal and provides an output signal at 16 mc. The 16 mc signal is then tripled in a standard tripler circuit to 48 mc and fed to the 832A tripler-driver. The 144 mc output of this circuit drives the final 832A amplifier to about 12 watts output on two meters. The modulator portion of the transmitter starts out with a carbon microphone (with its attendant battery and transformer), feeds the audio signal through a driver stage and finally to the push-pull output.

The modernization of the rf section of the transmitter discussed in this article consists primarily of changing the tube types used in the first two stages; the 832A driver and power amplifier are retained. These last two stages could be modernized to a pair of 6146's, a 5894, or even an 829B, but it would really serve no useful purpose. The 832A is available on the surplus market, provides a pretty potent punch and the price is right. However, the modernization of the modulator section is a completely different story. This circuit is completely revamped for use with a crystal microphone using modern tubes and components.

The first step in this modernization is the complete rehabilitation of the audio section. Since this section is going to be completely rebuilt, strip out all the octal tubes, sockets and associated components; remove the microphone transformer (#158)*, the driver transformer (#159) and the 250 ohm audio control (#125). Also remove the —150 volt bias line that goes to the center tap of the driver transformer and cut it off where it terminates at the resistor terminal board.

Cut a piece of thin sheet aluminum, laid out as shown in **Fig. 5**, and install it in the audio compartment of the —522. This mounting plate has been laid out so that each of the new tube sockets fit into the old octal cutouts. The only holes that have to be drilled in the —522 chassis are the four mounting holes at the corners of the aluminum sheet. After installing the tube sockets, wire the unit according-

* **NOTE:** The three digit numbers given in the parenthesis and shown in the schematics refer to the three digit numbers stamped on or near the respective -522 components.

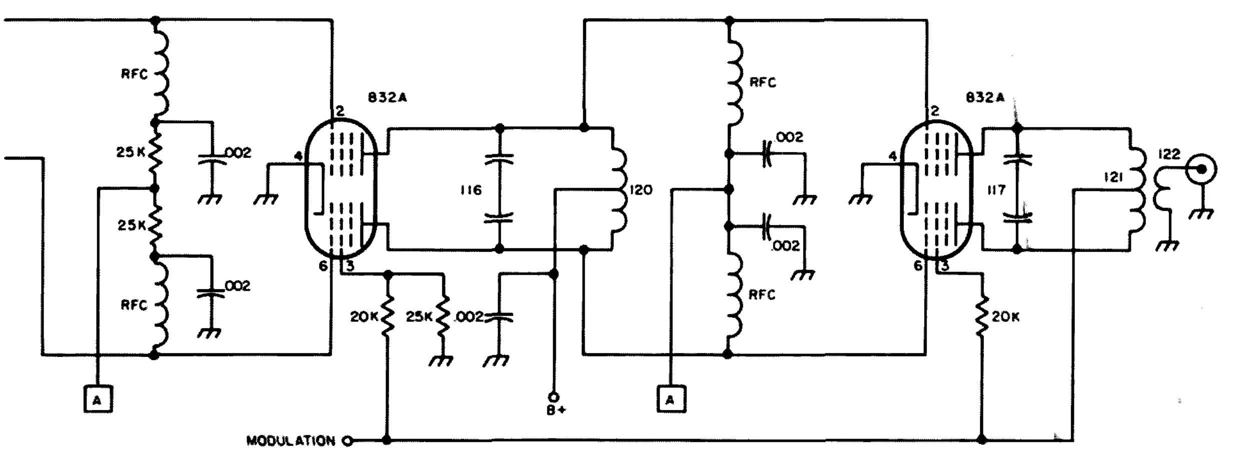


Fig. 2. 832A tripler and 832A final. The three digit numbers are original parts numbers from the SCR-522.

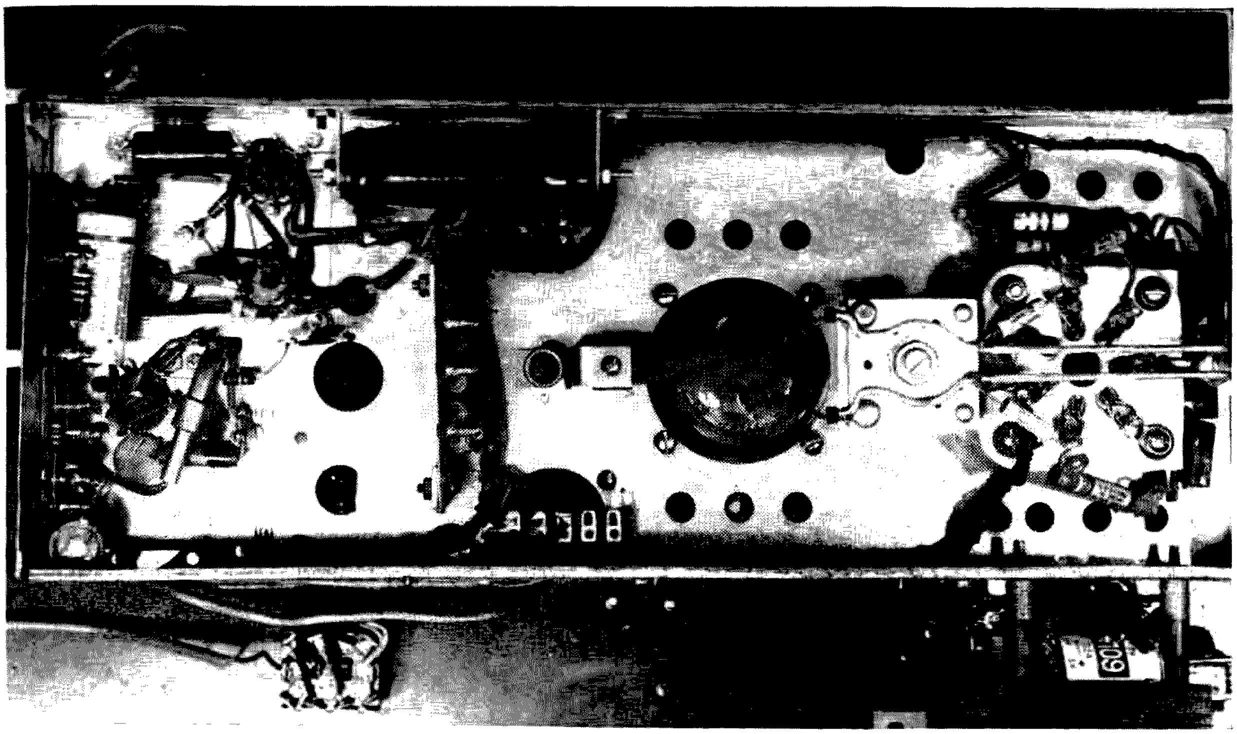
ing the schematic of **Fig. 3.** Parts layout is not critical except for the input to the first 12AX7. Care must be taken here to use short leads to prevent rf feedback. Other than this precaution, the audio circuitry is quite straightforward. Most of the components may be mounted on the terminal strip at the bottom end of the chassis or at the tube sockets. The 500 K audio control is mounted in the chassis hole vacated by the old 250 ohm pot. Cut the shaft on this control so it is 1⅜ inches long; this will provide sufficient length when the front panel is installed. In the original design of the −522, wiring to the audio control and microphone jack was routed through a piece of tubing which is attached to the chassis. In this modernization, the wiring is still routed through the tubing, but shielded grid wire is used for added isolation.

If more than 275 volts is going to be used, a dropping resistor (R_x in the schematic of **Fig. 3**) must be placed in series with the high-voltage line to the audio compartment to prevent damage to the audio tubes. The complete audio section requires 75 mils of current so the value of this resistor may be determined by Ohm's law; just subtract 275 from the supply voltage and divide this difference by 75 ma. In the author's case where 425 volts is used, a 2000 ohm, 20 watt wirewound resistor was used.

After the modulator is completed, the crystal oscillator and first tripler stages must be converted to modern tubes. In these two circuits all that is replaced is the tubes themselves, the rest of the circuitry is identical to the original design. First of all, remove the two tubes and octal sockets in the final amplifier compartment. When removing the various connections from these sockets, use a soldering tool so that the existing capacitors, resistors and wiring are retained. In a few cases the lead lengths will be too short for use with the new 6AQ5A oscillator/doubler and 6CL6 tripler, but the existing parts are used as much as possible. When removing the leads from the octal sockets, it's a good idea to label each one as it is removed. Short pieces of masking tape may be attached to each lead and appropriately labeled. If this is done it will be a lot easier to wire the new sockets when they are installed.

When the octal sockets are pulled out and the circuitry is exposed, it's a good idea to replace all of the old mica bypass capacitors with modern high-quality units. This is not absolutely necessary, but it will preclude any future problems with these old capacitors. It's a little easier to replace them now than wait until the chassis is all buttoned up. This is also a good time to rewire the 832A filament circuits for 6.3 volts. This is accomplished by removing the existing ground on pin 7 of the 832A sockets, wiring pins 1 and 7 together, and tying pin 5 to ground. This is a little difficult to do on the 832A tripler/driver, it *can* be done. The new tubes are all wired for 6.3 volt filaments during the initial installation; this is shown schematically in **Fig. 4.**

Now cut a small aluminum sheet as laid out



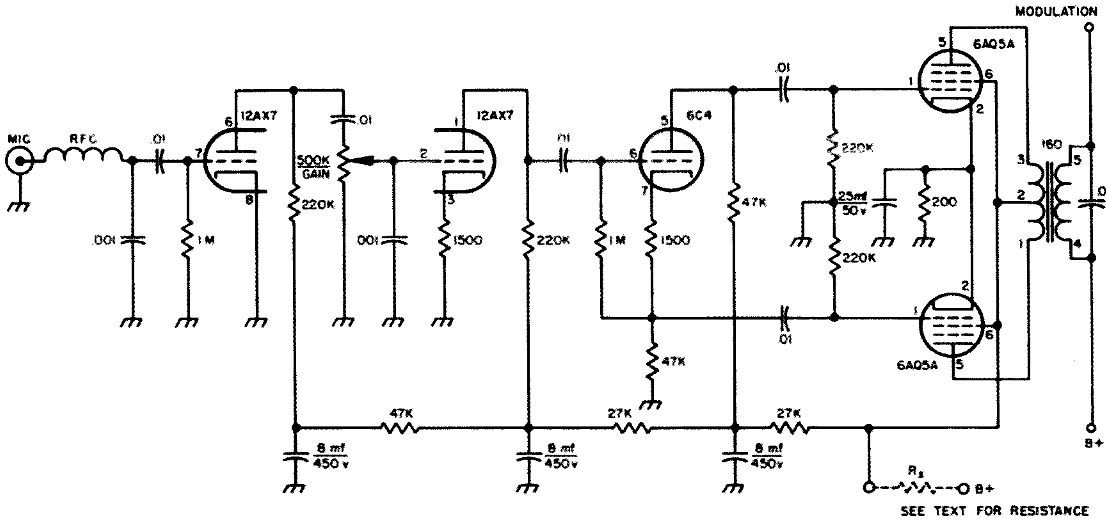


Fig. 3. New modulator to replace the original modulator designed for carbon mike input.

in **Fig. 6** and install the tube sockets for the 6AQ5A and 6CL6. Install this aluminum plate in the final amplifier compartment and wire the sockets according to the schematic (**Fig. 1**), using the components that were labeled when the octal sockets were removed. Since the new circuitry uses approximately the same layout as the old octal circuit, no trouble should be experienced. However, in some cases new components will have to be substituted because the leads on the old parts are too short.

In addition to the normal circuit wiring, install two wires about three inches long, one to pin 7 of the 6AQ5A, the other to ground; these wires will eventually be connected to an external crystal socket. Also connect two wires about six inches long to the meter jacks; these are routed along the front edge of the chassis and will be attached to the 1 milliampere meter after the front panel is installed.

While you are still working in the final amplifier compartment, remove the 6SS7 rf detector from its socket and install a IN34A diode between pins 5 and 8; the cathode goes to pin 5. The output from this detector is quite low, but it does give a relative indication of rf output.

The only metal work on the −522 chassis consists of cutting a ⅝ inch hole in the chassis over the old antenna output terminals for mounting a coaxial chassis connector. A type N connector was used by the author because of its superior characteristics at these frequencies, but an SO-239 (type UHF) could probably be substituted with no noticeable difference. A coaxial relay is mounted directly to this output connector through a double male coaxial adapter (type N, UG-57B/U; type UHF, Dow-Key type F-2).

The −150 volt bias supply is constructed as shown in the schematic of **Fig. 4.** The filter components and bleeder resistor are mounted on a piece of phenolic board, 2 inches wide

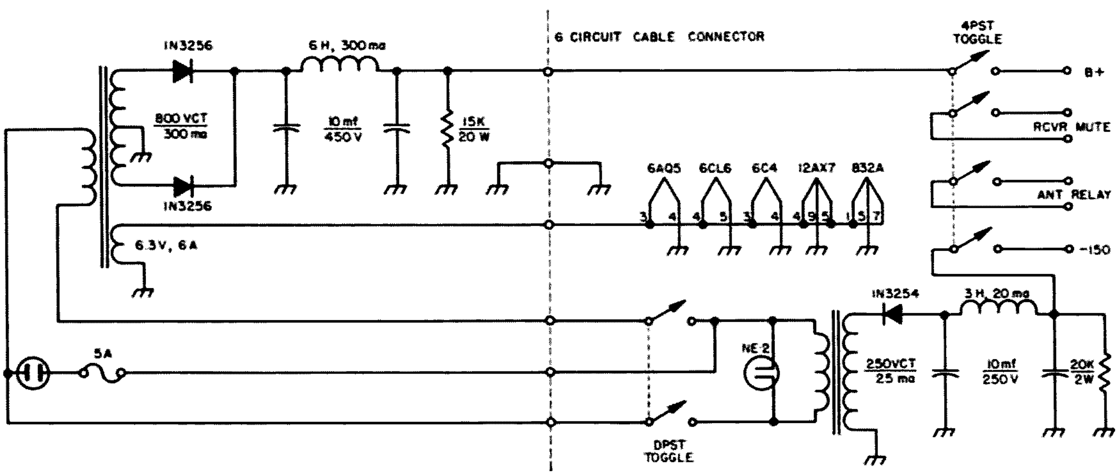


Fig. 4. Power supply for the converted SCR-522.

and about 3 inches long. This terminal board and the power transformer are mounted to the chassis with standoffs as shown in the photograph. Although the schematic indicates the use of a small choke, the total current drain of this supply is only 6 mils, so a 2 watt carbon resistor (about 2000 ohms) could be substituted in place of the choke with almost no difference in 60 cycle filtering. In the supply shown in the photographs, the output voltage is just about −150 volts. With different parts, the voltage may differ somewhat and it will be necessary to use a voltage divider on the output to obtain −150 volts.

Two 6 lug terminal strips (H. H. Smith type 3006) are installed in the bottom of the chassis adjacent to the 832A tripler/driver stage and all power and control wiring is brought to these points. This may seem like gilding the lily, but it aids immeasurably in wiring and in any maintenance that might be required at a later date. I might also add that neatness and appearance are considerably improved. All of the power and control circuitry is wired as illustrated in **Fig. 4.**

Basically, the modernized −522 transmitter is controlled by two toggle switches; one for filament and bias supply control, the other for the transmit/receive function. Note that although the wiring for these switches is shown in **Fig. 4,** there is no pilot light shown for the transmit/receive function. This is because the "transmit" pilot light is wired in parallel with the antenna relay and is powered from the same 115 volt source. The filament switch is a standard DPST toggle, but the transmit/receive switch is a 4PDT unit. This latter toggle switch (Arrow-Hart & Hegeman type 82636) is rather expensive but it is still less costly than the SPST toggle switch and 115 volt relay required to do the same job. A rotary switch could be used in this position at a slightly lower cost.

The entire transmitter chassis is mounted on a standard 19 inch aluminum rack panel as laid out in **Fig. 7.** Although a fourteen inch panel is shown here, a smaller panel may be used with only slight sacrifice in usable panel space; it just happens that this panel was available at the time the conversion was made. Three-quarter inch long, ⅜ inch diameter phenolic spacers (H. H. Smith type 2143) are used between the panel and the chassis to provide clearance for the various mounting screws and hardware on the face of the chassis. The four square variable capacitor shafts are disconnected from the ratchet mechanism, cut off at the machined shoulder, and extended through the panel with standard "¼ to ¼" shaft extenders (H. H. Smith type

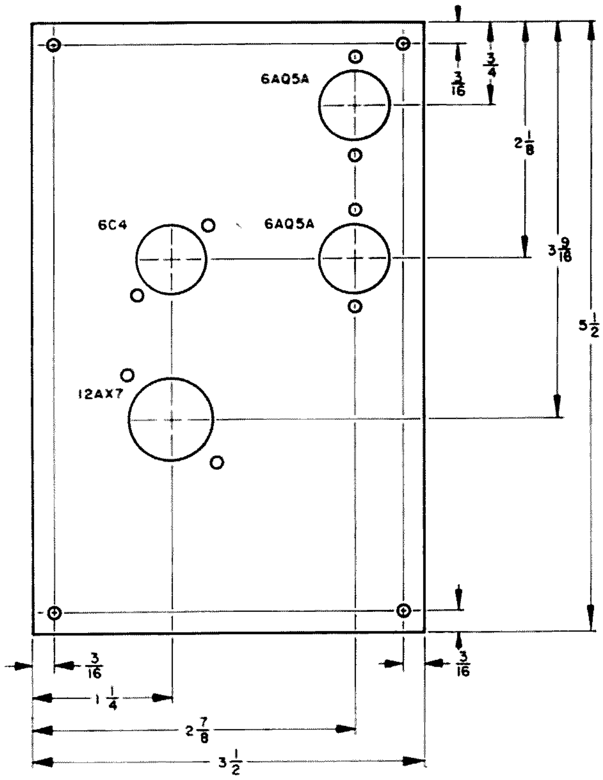
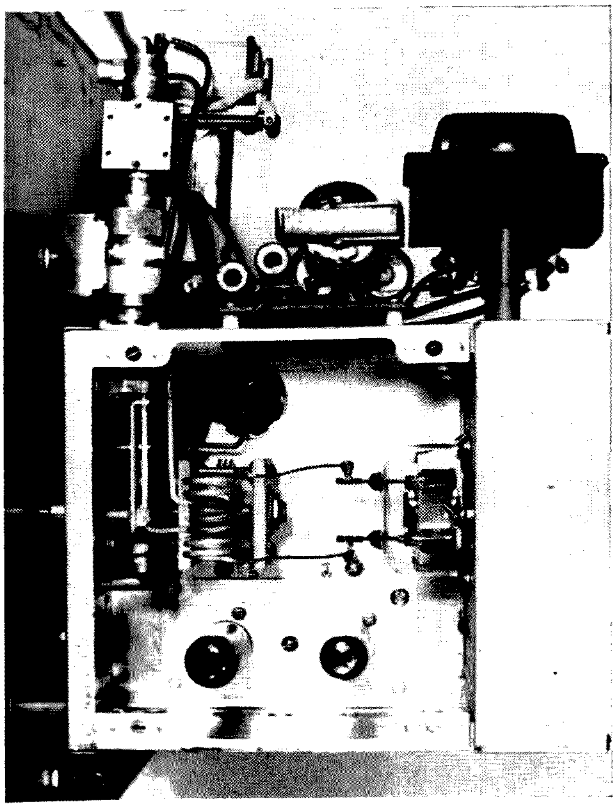


Fig. 5. Mounting plate for new audio circuitry



Final amplifier compartment of the modernized SCR-522. The 6AQ5 oscillator/tripler and 6CL6 tripler are mounted on small plate at the bottom of the compartment. This view also shows the bias supply (upper right) and antenna changeover relay (upper left).

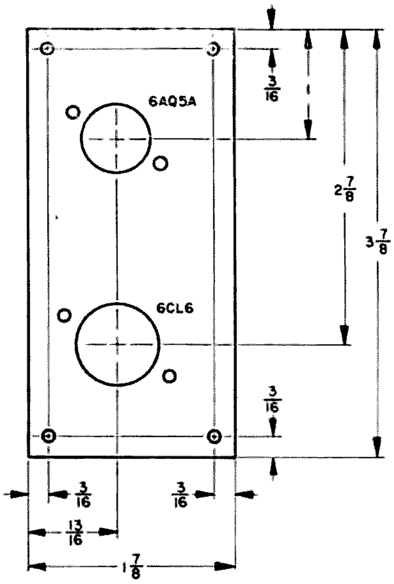


Fig. 6. Aluminum sheet for mounting new rf tubes.

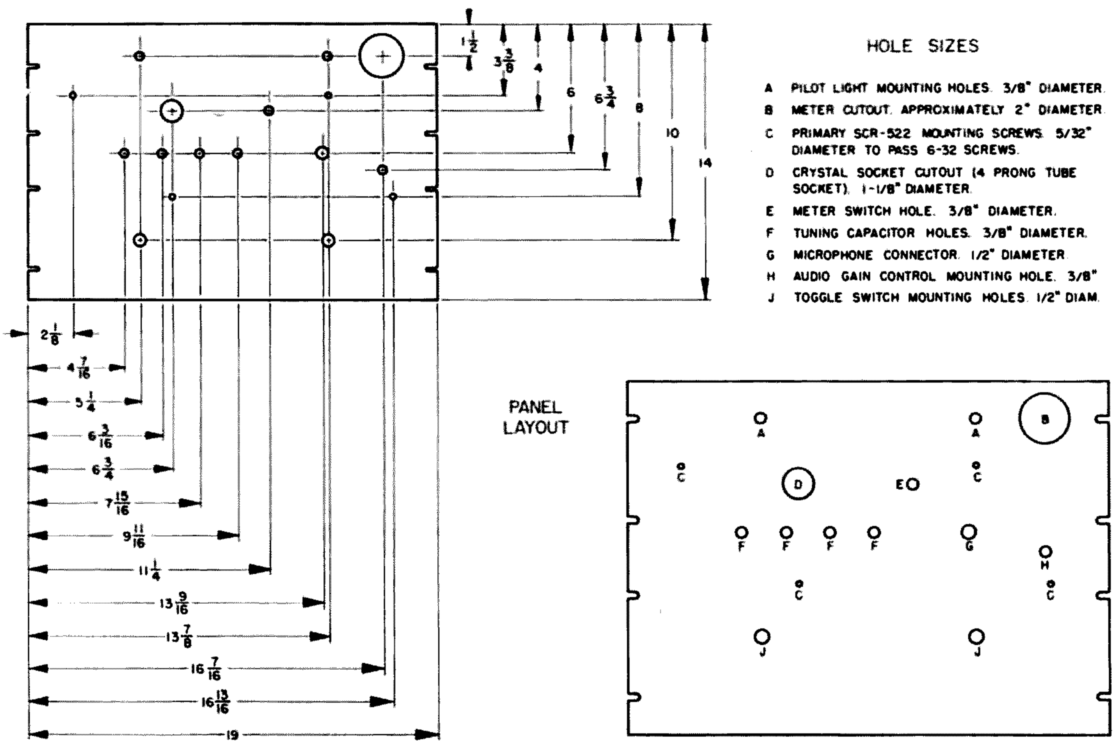
150). A shaft extender is also used with the meter switch, but none is required for the new audio control.

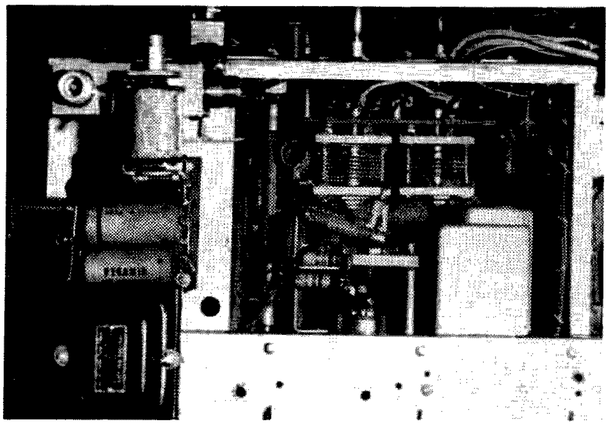
The chart mounted on the face of the panel, as shown in the photograph, is simply a conversion chart showing the two-meter output frequency for common 8 mc crystals. It is held in place with a piece of ⅛ inch clear plastic and four mounting screws.

The crystal socket is a standard four-prong tube socket with two pairs of contacts wired in parallel. This permits the use of different sized surplus 8 mc crystals of the FT-243 and FT-241 series. Another small socket will have to be added (or an adapter made) for the smaller HC-6/U type units. The one milliampere meter and microphone connector are also installed on the front panel and wired into the circuit with the wires provided. When wiring in the microphone connector, make sure you have a good ground connection to the main chassis; a poor ground or bad solder joint at this point will result in all kinds of hard to find regeneration and instability.

The meter switching is not illustrated in the schematic drawings because of the added complexity and the fact that it is not modified in any way. Essentially, the meter circuit consists of switching a one milliampere meter across low resistance shunts which remain in the line all the time. The meter switch positions (moving in a clockwise direction), function, and respective current readings are as follows:

Position 1	6CL6 plate current	40 ma
Position 2	832A tripler/driver plate current	50 ma
Position 3	832A final amplifier plate current	60-70 ma
Position 4	Diode r-f detector output	1-3 ma
Position 5	Final amplifier grid drive	1-2 ma
Position 6	Meter off	—





Top view of the transmitter shows the —150 volt bias supply and coaxial relay on the left and butterfly tuning capacitors in the center.

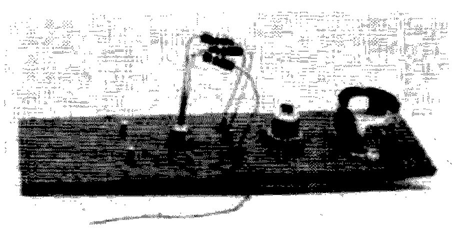
A grid-dip meter or other frequency indicating instrument must be used during the initial tuneup. Since this transmitter was originally designed for operation on any frequency between 100 and 156 mc, its tuning range is quite wide. In addition, the variable butterfly tuning capacitors operate over a 90° range as opposed to the conventional 180°, so some method must be used to ensure that each stage is operating at the correct frequency. As an aid to subsequent tuneups, all of the variable capacitor control knobs are oriented so that they point straight up when the transmitter is ready to go on two meters (see photograph). The stages are initially tuned as follows:

Crystal Oscillator/Doubler	6AQ5A	16 mc
Tripler	6CL6	48 mc
Tripler/Driver	832A	144 mc
Final Amplifier	832A	144 mc

Any high-voltage power supply that provides from 300 to 600 volts at about 235 milliamps and 6.3 volts a-c at 6 amps is suitable for the modernized SCR-522. This may be realized quite easily with an old TV power transformer and silicon diode circuit wired as shown in **Fig. 4.** Occasionally the RA-62B power unit appears on the surplus market at a nominal cost; this unit was designed specifically for the job, but requires the use of 12.6 volt filament tubes.

This transmitter has been used for several months and has provided good performance both as a two-meter transmitter and as a driver for 432 mc gear. The modulation is exceptionally clean and has resulted in many excellent reports. On two-meters, Q5 contacts have been consistently maintained over 75 mile paths using this transmitter and a ground-plane antenna. All in all, it has proven to be a worthy investment for the small amount of time and money involved.

. . . WA6BSO



The Ultra-Breadboard

W3ITO's article "PRINTED CIRCUITS—ALMOST" in the March 1965 issue of 73 prodded me into disclosing to the waiting world an intermediate step between the circuit drawn on paper and the finished product as shown in the W3ITO article.

Usually there is a lot of experimental work to be done before the project is finished. The circuit as drawn on paper just doesn't perform as planned and the finished product is found to be full of unused holes and odd locations for some of the parts.

The Ultra-Breadboard was born to fill the need of a cheap method of trying out new ideas and getting final layouts without destroying the usefulness of the parts used.

⅛ inch Masonite Prest-Wood and number 14 bare copper wire are the only materials needed and both are readily available and cheap. Your regular socket hole punches and other tools normally found around the shack are all you will need.

The first step is to draw the *CIRCUIT* you are going to use in the project. Then, using *OUTLINES OF THE PARTS* lay them out on a piece of paper, using dots to indicate tie-points. Transfer the dots to a piece of Prest-Wood and drill with a 5/64 inch drill. Insert short pieces of the #14 wire through the holes. If a small flat is pressed into the wire where it will be imbedded in the Prest-Wood, the wire will be held securely.

Solder the various parts to the tie points and try the thing. If it doesn't work to suit, simply change parts, rearrange things till you get things perking and then go to the layout in W3ITO's article.

It isn't necessary to cut the leads to resistors and condensers unless you are working on UHF or VHF equipment, and the parts can be recovered undamaged to use on the next project.

A small loop on the end of one of the wires permits several parts to be soldered to the same tie point. Another advantage is that since the wires project on both sides of the board, only those parts which are to be experimented with are soldered to the top projections, other wiring is done on the bottom out of the way.

. . . WØPHY L. A. Stapp

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The First and the Last Q-5er

The ubiquitous command sets based on the Type K "channel" design were the most numerous single type of radio gear to come out of World War II, and the low frequency receiver, the "Q-5er" was the longest-lived component of that prolific breed.

That most durable command set covered 190-550 kc in its final design. It was the first to be put on the drawing boards in 1935 and its civilian version was manufactured by Aircraft Radio Corp. into the 1960's, a fantastic life span in a 25 year period of electronic advances which reached from the TRF receiver to satellite computers.

The last military-sponsored set in the Command line was a Navy project, designed in the waning days of the war as a modification of the command receiver. It incorporated modern automatic gain control and diode noise limiting while abandoning the CW oscillator and the outputs for the by-then defunct ZA instrument landing system.

Historically, Aircraft Radio Corp. had come into being in 1928 with a low frequency (200-400 kc) tuned-radio-frequency receiver for the fledgling air lines of that day. The original Radio Frequency Laboratory Model R was bought by the Signal Corps and the Bureau of Aeronautics in a military version which lasted to see action in the disastrous early days of World War II, 13 years later.

The fatal mishaps in the Army Air Mail flights of 1934 set the stage for a new radio type for the Air Corps, the superheterodyne. The Aircraft Radio Corp. "channel" receivers were designed to meet that need in 1935-37, at first for the Army, but finally for the Navy, which saw the value of the design when the Army could not.

The first "Command Set" was a 200-580 kc receiver, painstakingly hand-assembled at A.R.C.'s tiny Boonton, New Jersey, plant. It used double-ended tubes in RF and *if* stages, plus a new tetrode output stage using, during development, three tubes built for A.R.C., the RCA type 1278, the Raytheon CK-45, and the Sylvania S-392. The 1278 was later standardized as the 12A6.

Among advances in the set were small mica button capacitors, assembled of silvered-mica wafers on a stainless steel stud. They had accuracy and stability parameters significantly above the then-industry standard.

Small paper and electrolytic capacitors were designed for bypass and filter functions by A.R.C. and Cornell-Dublier, a nearby New Jersey firm.

Special switches, *if* transformers, chokes and output transformers were hand-built at A.R.C. along with specially-machined hardware and painstakingly formed chassis and other sheet metal components. Riveting was an art perfected by A.R.C. machinist John Johanson for what were, by 1936 standards, extremely miniature components.

Automatic volume control circuits had been worked out by A.R.C. engineers ten years earlier before the Corporation had sold the Radio Frequency Labs trademark and patents. The second hand-built channel receivers contained a wide-range AVC circuit, with front-panel AVC controls.

The new design went to both the Navy, at Bellevue, in Washington, D.C., and to the

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Army's Wright Field, Ohio, test facility. The Army did not buy it. The Navy did.

In the confusion of the 1940-41 buildup of U.S. air forces the Type K Command Set (including the familiar Command transmitters and other components) was bought by both the Army and the Navy. It was first made as Navy Type RAT and RAT-1, then, jointly, as SCR-274-N (for Navy), with agreements on specifications which included a rudimentary AVC. This design applied only enough control to the RF and *if* stage grids to prevent "course reversals" through RF overloading when flying the low frequency navigation ranges of the day.

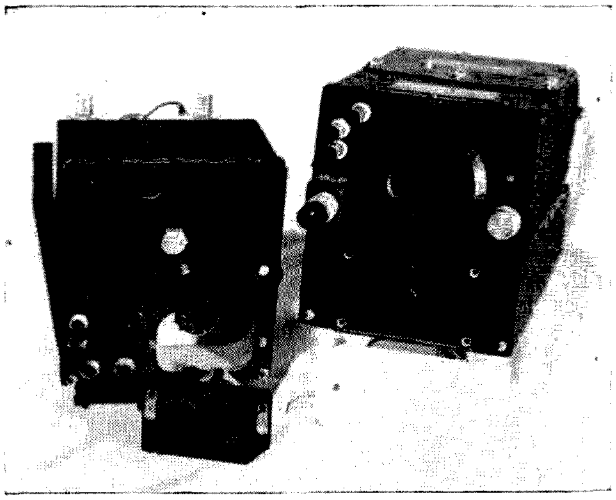
The AVC designed into the second series of Type K receiver prototypes derived a bias voltage from the same diode detector leak used to furnish audio output, fed back to the control grids of the variable mu (remote cut off) 6K7 RF and *if* tubes. Manual gain control was achieved by grounding the AVC line and varying a resistance in the RF and *if* cathode circuits.

The SCR-274-N and Navy ARA AVC circuit derived bias voltage across a 100,000 ohm resistor, bypassed for audio, in the grid circuit of the last *if* tube. The voltage developed there at high RF levels was applied to the grids of preceding stages. The system preserves the modulation envelope pretty well for subsequent detection. (When the detector diode feeds a delayed AVC line, extraction of power from the *if* circuit by the AVC only at the top of the modulation envelope tends to distort the audio peaks. This drawback was overcome in the latter AN/ARC-5 sets by using undelayed AVC clamped by a shunt diode which provides the required "delay" in the AVC action) "blocking," which the SCR-274-N and ARA sets were designed to defeat would have given spurious navigation information by giving decreased output with increased input beyond a certain RF input level.

The RAT, RAV and ARA designs were virtually identical with the SCR-274-N (N for Navy) production through 1942, but changes were in the wind.

Crystal control had become practical. Stability was of the essence. Command sets were being used for fleet communications over much longer distances than the design basis of short-range plane-to-plane work. Combat pilots could not twist volume control knobs continually. Special instrument landing system equipment was used with teh Command system.

The author has already described the Naval Research Laboratory Crystal-controlled command set—with AVC—circa 1943. Official Naval correspondence reveals the problems



On the left is the Model 1, Serial 1 low frequency Command receiver, circa 1936. Note the slightly different front panel control panel, the phone jacks and different placement of the antenna and ground fittings. The dial was adapted from the Navy RU series receiver.

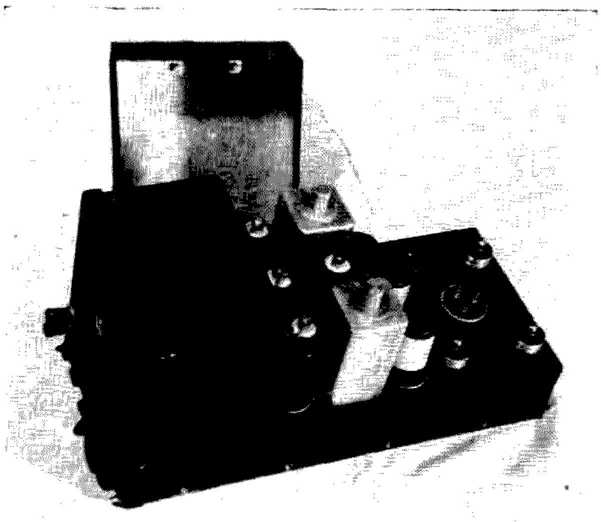
which cried desperately for improved gear to handle the new demand of the services. The Army itself sent A.R.C. President Dr. Lewis M. Hull to Europe with General Harold McClelland to see what could be done to improve communications in the Eighth Air Force.

Dr. Hull's highly-classified recommendations: remove all controls except volume from the pilots' panel; locktune or crystal-control the Command Set, and add AVC to make even the volume control unnecessary.

Back in Boonton A.R.C. engineers attacked both problems. Under a contract calling for receivers to operate with the ZA ILS system, with the assistance of Air Track Corporation engineers, the low frequency command receivers were overhauled. Delayed AVC of a more conventional type was applied to the 190-550 and 520-1,500 kc receivers and cathode follower outputs were provided to the ZA equipment in the aircraft.

The product was the R-20, R-21, R-22, R-23, R-24 receivers. The first three, covering 1.5-9.1 mc retained the SCR-274-N AVC, while the navigation sets were more drastically altered. All five bands were given new, redesigned, temperature-compensated front ends, additional use of ceramic dielectrics, and new external controls. A type 12SF7 *if* tube was specified in order to provide proper bias on the cathode of the AVC stage in the new design, and to avoid interaction between the AVC and the BFO circuits.

Before R-20, R-21 and R-22 production was put into high gear the Navy decided to put full AVC into all the command receivers. The



Top view of the first Q-5er. The set used only two 90 kc if circuits. Designer Paul O. Farnhom said recently "the use of three tuned if coupling units on the two lower frequency bands was not deemed proper because two such tuned units appeared to give adequate gain and selectivity. We changed our minds later." Tube lineup in this set included 6K7 RF and if tubes, 6L7 mixer, and 6H6 detector. Audio and BFO tubes were experimental Raytheon CK-45 power pentodes with 6.3 volt heaters designed for A.R.C.

modified sets were labeled R-25, R-26 and R-27 in the AN/ARC-5 series.

The tuning capacitor in the ARC-5 series was a completely new component. It was so built—out of brass and invar (36% nickel) steel, as to have a slight (.000015 pf/pf/degree C.) negative coefficient, i.e., with normal warmup heating it would decrease in capacitance. (An un-compensated capacitor would be expected to increase markedly in capacitance with temperature.)

The warmup of the oscillator tube and the oscillator tank coil would tend to increase the circuit capacitance. The negative tuning capacitor behavior would thus tend to offset that change. Residual changes were absorbed by an additional small (3 pf) "padder" with a negative coefficient of 750 parts per million per degree centigrade.

Unfortunately the R-23 and its sister R-24 (520-1,500 kc) receiver suffered from low audio output problems. Back at the drawing boards the A.R.C. Engineers under designer Dr. Frederick Drake made more changes.

Output with the improved circuit was increased from 120 milliwatts for the standard input of 10 microvolts at 1000 cycles modulated to 30 percent to better than 400 milliwatts.

This new model—the R-23-A/ARC-5—was accepted by the Navy in 1945 despite the fact that the test aircraft at Anacostia Naval Air Station in Washington was equipped with a 14 volt electrical system. (The R-23-A was a 28 volt receiver.) Engineer Norman J. Anderson recalled recently that a planeload of Navy brass found the set highly improved despite the half-voltage on the tube heaters.

Shortly afterwards the Navy ordered the R-148/ARC-5x, a 14 volt model of the R-23-A.

By the end of the war the ZA ILS system had disappeared. The low-frequency command receiver became a standard item on all military aircraft for range nagivation even though the transmitters and receivers for other bands were abandoned and the CW oscillator joined the ZA in disuse.

Although the R-23-A was now standardized, low-frequency navigation was disappearing. By 1960 it was a relic in North America and obsolescent overseas. VHF Omni had replaced it. The R-23-A remained as a little-used standby in transport aircraft, a role it still plays, today, in 1966, thirty years after it was designed.

The final improvement in the receiver was noise-limiting, proposed by the Navy in 1946. The 12SR7 BFO tube and the BFO transformer, plus the ZA output circuits were dropped. In their places were added a 12H6 double diode and a noise-limiter control relay. The 12A6 output tetrode was replaced by a tetrode-diode tube under the RCA experimental number A-5023.

Noise limiting had first been applied to command receivers in the 1944 VHF receiver design, following techniques developed by the British in wartime research. It had been the subject of considerable research in both private and government labs in this country, with detailed work done by Maguire Industries under a Navy contract.

The R-112 and R-112/ARC-5 receivers used diode-connected triode noise limiting circuits, but the R-23-A was built with the 12H6 twin diode tube. AVC in the set was delayed by using the diode in the 12SF7 *if* tube as a clamp to prevent AVC voltage from appearing at the RF and *if* grids until enough AVC voltage had been generated to override the 30 volt cathode bias on the 12SF7 tube.

The modified R-23-A was examined at Wright Field and at NRL in 1945 and 1946. At the same time competitive bidding on R-23-A procurement brought in the Lewyt Corporation and Stromberg Carlson. The former failed to fulfil an 1,100 set contract according to specifications and the latter finally dropped command set production. A.R.C. officials were stung by the postwar military procurement depression and moved into the

civilian market. The Command Sets were finally demobilized and dressed in gray peacetime paint.

Engineer Paul O. Farnham, the designer of much of the command gear, told this writer he was disappointed to see the command design changed, the dial discarded, the plug-in RF and *if* feature abandoned, and cost made a higher consideration than maintenance convenience.

But in many ways the postwar gear was very good. The best materials were no longer scarce. New ceramics and modern finishes including better insulating varnish and other top-quality components were now available. Locktal tubes such as the 14A7 and the 14R7 were ready. They eliminated the moisture-holding tube base of octal tubes and offered improvements in reliability.

Early R-11 (civilian) receivers returned to the twin-triode NL circuit, but VHF gear was built with a double triode AVC-NL-detector designed by Farnham, using an unbypassed audio cathode resistance. Later (1958) a highly effective squelch was added to this circuit.

The dial-less, ceramic-insulated locktal-tube command set was basically designed in 1946 by Engineer Norman J. Anderson with only slight changes from the modified R-23-A to adapt the postwar tubes.

The last 15 years of command set production was devoted chiefly to these civilian versions, R-10, R-11, R-13, R-15 and R-19 which were bought in large numbers by the military for use in the Korean conflict in 1950-54. Aircraft Radio Corp. was rescued from the postwar aircraft equipment depression by the demand of the Army and Navy for lightweight radio gear to be used in helicopters and spotting planes like the L-17 Navion, the L-19, and aircraft as large as light twins and jet trainers such as the T-37.

Much of the business went into Cessna-built light planes, an association that culminated in 1957 in the purchase of A.R.C., by the Cessna Corporation. The transaction came at the time that crystal control was becoming mandatory in civil flying and transistors were revolutionizing electronic design.

Most of the old hands at A.R.C. have now left Boonton. President Lewis Hull, Field Engineer Al Parkes, Paul Farnham, Norman Anderson, John Johanson, and the father of the command sets, Dr. Fred Drake were all retired from A.R.C. by 1961 when the last Command receiver left the white clapboard plant in Boonton, N.J. The Command Sets, and an era, had ended.

. . . White

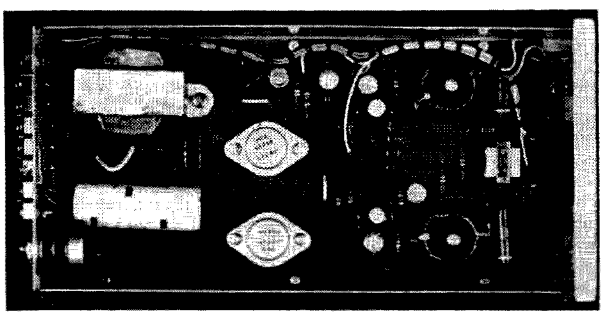
The Stoner RT-1 RTTY Converter

ized, it is quite small and light-weight. For more information, write to Stoner Electronics, Alta Loma, California. . . . WA6BSO

The new Stoner RT-1 radioteletype converter provides a simple and economical way of getting on the local RTTY net. If you have a receiver and a printer, the RT-1 is the only accessory necessary to copy ham RTTY qso's, press stations and other 60 WPM radioteletype transmissions. This is particularly advantageous because with many converters, both commercial and homebrew, a separate bias supply is required to furnish 60 mils of printer magnet current; with the RT-1 the necessary supply is built in.

This converter is very simple to use and if you already have the receiver and printer, it only takes about five minutes to hook up and start copying RTTY signals. All you have to do is connect the converter between the 500 ohm output of the receiver and the printer. In the event your receiver does not have a 500 ohm output, a matching transformer should be inserted in the line. After the RT-1 is properly connected, there is one adjustment that has to be made; this is the adjustment for exactly 60 ma of printer magnet current. This is quickly and easily done with a control mounted on the rear of the converter. This unit is completely transistorized and has a built in meter so an accessory tuning indicator such as an oscilloscope is not required for proper tuning.

The operation of this converter is very straight-forward; the audio signal from the receiver is fed into an impedance matching transformer which steps the 500 ohm line up to 10K to feed the transistor circuitry. The first transistor in the circuit limits and amplifies the audio signal. The amplified tone is taken from the collector and fed to two toroidal filters, one tuned to 2125 Hz (space), the other



to 2975 Hz (mark). The tuned circuits are link coupled to the mark and space detectors. The output of these transistorized detectors consists of a square wave which varies in step with the keyed RTTY signal. A meter is inserted into the circuit so that it sums the detector collector currents. When an RTTY signal is properly tuned in, the two currents are approximately equal and the meter reads a steady upward deflection.

The square wave outputs from the class B transistor detectors are used to key a two transistor squaring stage. The output from this squaring circuit is a nearly perfect square wave replica of the original RTTY keying signal. This square wave is the correct shape to drive the printer magnet, but has insufficient current to actuate the armature; therefore it must be run through a d-c amplifier. The necessary amplication is accomplished in a switch driver and the amplified output used to initiate operation of the printer magnet switching transistor. Normally this stage is conducting continuously and the RTTY pulses interrupt the current flow to initiate printing. A transistor current regulator is connected in series with the switching transistor and is set for 60 ma through the printer magnet coil.

Although the Stoner RT-1 converter was designed specifically for 850 Hz frequency shift keying, shifts of other than 850 Hz may be copied by setting it for single channel operation. Simply tune the receiver to where the printer magnet chatters the loudest (with the printer drive motor off). If the copy is still garbled, change the "normal-reverse" switch and retune the receiver. If the copy is still garbled, chances are the RTTY keying information is being transmitted at other than 60 words per minute, the standard for amateur operation.

If you are contemplating RTTY operation, for $99.50 the RT-1 appears to provide a simple and economical approach to the converter problem. It eliminates the bulky printer magnet current supply and being transistor-

Team up an old Standard Coil TV tuner with that old RDZ for a useful shack receiver.

Robert Ream K3HIL
200 Wynwood Road
York, Pa. 17402

Five Band VHF Receiver from an RDZ

The conversion of this receiver to a 5 band VHF receiver is a worthwhile project. Although this rig would never be used for a portable or mobile operation, (weight 150 pounds), it is a fine addition to any ham shack. While the first part of this procedure might seem harsh, it is necessary so that the receiver may be utilized for more than one band. First, remove the front panel covering the dial and crystal compartment. Also release handle latches and pull out chassis from the cabinet.

Looking in from the front, on the left you will see the automatic tuning unit and the preselector converter unit. All of this must go, as it won't be used except the first IF transformer which is on the right rear corner of the converter unit.

These units come out in two seperate pieces, the automatic tuning unit is removed through the front and the converter unit is removed from the bottom. This is done by removing the braces and metal work directly under this unit. This can then be stripped of all parts or a similar chassis can be installed for the next phase. You will notice 3 wires coming in from the power supply. They are AVC, B+, and filament.

Cut these wires off at the chassis as longer wires will be used later. Also, if a new chassis is used, be sure to save the first IF mounted on the converter unit.

The heavy cable that was fastened to the terminal strip of the automatic tuning unit can be cut off or removed at the inside rear of the cabinet, as the antenna coax wire is inside this cable. You might want to split open the cable and save this as it will be easier than running a new coax from the rear panel.

Now, remove the cover from the power supply and lift B— and run a wire from this point up to the front panel and install a toggle switch directly under the meter adjustment pot.

Next step is to find a Standard Coil tuner from a junked TV set. Most of these sets were manufactured between 1950 and 1960. The make or model doesn't matter as long as it has a Standard Coil tuner. Take the tuner apart by removing the turret and examine all parts especially for burned resistors, broken tube sockets, etc. . . Clean the contacts, and with the turret recoved, find the IF output coil and remove this from the circuit. This coil went from the oscillator plate to the IF's of the set.

Now, install a 470 ohm ½ watt resistor from the plate to an 18 inch length of the 72 ohm coax, ground the shield and run through a hole in the back of the tuner, leaving room for the turret to turn. Install longer wires on the tuner, B+, AVC, and filament, and install the turret.

Now, temporarily connect filament leads to the receiver power and using a grid dipper, check out channel 2 coils, and see how far down you will have to move for 6 meters. By padding with small capacitors or by adding a couple of turns of the same diameter wire, you can put it right on the button. This procedure is used on all bands 27, 28, 50, 144, and 220 MHz.

The fine tune control is used to tune the band. In the 10 meter position the fine tuner will cover the band, on 6 meter the first megahertz.

If more range is needed, wind another set of coils and insert in next position of turret. On 2 meters, it will tune about 2 megahertz and so forth. Most of these tuners use a 6BG5 or 6BQ7 tube as the rf amplifier, and either 6J6 or 6U8 mixer and oscillator tubes. The coax from the tuner now goes to the first IF coil that was previously mentioned to save. The tuner is now mounted on the receiver chassis and a hole is drilled in the front cover for the shaft to protrude.

As these tuners are 300 ohm input a matching transformer from 72 ohm to 300 ohm was used as 72 ohm coax is used at this station to the antenna.

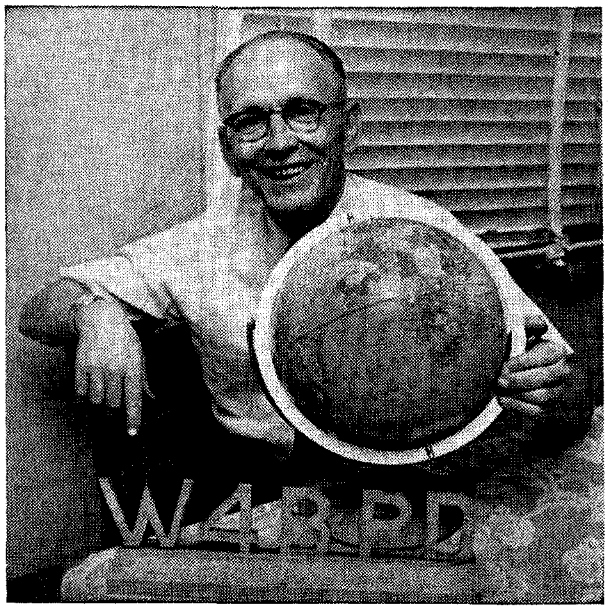
Some of these tuners require 2 B+, voltage, which can be picked up in the RDZ power supply.

By peaking the trimmers on top of the tuner on a weak signal, also adjusting the turret coils inductance, sensitivity will be increased considerably.

The IF frequency of this receiver is 15.1 MHz, so the oscillator coil has to tune the IF above the frefuency, such as 65.1 MHz for 6 meters. A 3 x 5 inch speaker was mounted on the opening in the front panel, and wires run to the terminal board on the right hand side of the receiver. Channel 2 coils were used for 6 meters, channel 7 coils used for 2 meters, and channel 13 coils for 220 MHz.

Rewire any of the other coils for the lover bands. You might want to wind a set of coils for 136 MHz, and listen to our satellites. With a grid dipper and a few parts, you will have a reliable receiver that won't take a back seat to any converter.

Connect all wires and with appropriate dial and knobs, you are in business . . . K3HIL



Gus: Part 12

Gus Browning W4BPD

In the last episode my first DXpedition had come to an end. I think I had learned a lot on that trip. I found that I did not mind traveling and really wanted more of it, in fact lots more of it. I had finally got to the point where I did not mind in the least getting tangled up with the customs in the different countries. I had found that I could eat anything that anyone else could with no bad effects. I found that I was not effected with sea sickness at all. Many more things were learned too, such as study the circuit in your rig so that you can troubleshoot anything that went wrong, take a few spare parts and of course spare tubes. Travel light, take your equipment along with you as excess baggage and don't under any circumstances ever let it get into the big custom houses in any country because these fellows at these places can't be made to rush and they have the big custom regulation books to refer to and they will read all the very fine print when you try to take your equipment out of their customs department. If you cannot afford to pay the excess baggage charges on your equipment you had better stay at home, since it does no one any good for you to be in some rare country and not have your equipment along with you to use. I had learned all of this and a few hundred more similar things, and I sure did hope that some day I would get to benefit from what I learned along the way.

When I arrived back home I immediately returned the equipment that had been loaned to me by a fine radio equipment manufacturer. The equipment had held up very nicely with the exception of some filter condensers blowing up on account of extremely high line voltages in a few places and I did have to use a number of the spare tubes. On this first trip I had used only half-wave dipoles, horizontal ones at that, and was hoping someone would come out with a good vertical ground plane, one that could be made up into very small sections and carried in a small canvas bag. I found out that Hy-Gain and their Model 14AVS were the answer to my problem, this model has now been changed to their Model 14-AVQ which is even better then their older 14-AVS and this is the one I have been using ever since. It's very FB from 10 thru 40.

Maybe their new model that goes thru 80 meters would be even better for a DXpedition and save a fellow from a lot of hard work when trying to get up an 80 meter antenna. Possibly they might even make up a sort of DXpedition special with the sections cut up in shorter pieces so it could be carried in a small canvas bag like the Model 14-AVQ I used on my last DXpedition. I admit a three-element beam would be better, but for a one man DXpedition I can just picture the difficulties I would face in trying to get something like this up and down in one piece. You cannot see the difficulties you face when you have about 4 to 10 people trying to help you put up an antenna when they cannot understand a word of English. Then there is the problem of "how will you turn it" when its mounted up in the top of an 80 foot coconut tree and anchored down on "W" land when the Europeans or Australians or South Africans are coming thru. Of course a good rotator would solve that problem. Then there is that other problem of paying all that extra excess baggage if you take the three-element beam and rotor, sometimes there is also the problem of length in some planes and also in every car that you might have to use in moving around in, in some countries. Another thing to consider when using a beam. It's turned on, let's say, W land and maybe at that time is also the best time for the VK boys, and you have the beam on W and you never know that this is the best time also for the VK fellows. In my opinion the only fair answer to the antenna problem is to use a vertical and give everyone a fair chance to work you, admitting that a beam would give your signals maybe one or two more S points. You are rare DX, so let the fellows

dig a little for you, it sort of makes the chase more interesting if you are a little hard to work. With a vertical no one can say that you have any favorite directions, its up to Ole Man Skip, and out of your hands. With two fellows a beam would be OK, if it can be turned with ease and doesn't happen to stay pointed at your favorite part of the world. For me it's a VERTICAL EVERYTIME.

Well here I was back home from my first DXpedition and everyone asking me "when the next one, Gus?" My answer was always, I have the time but I don't have the money. This usually stopped most of them. But there was a few who said raising money was no problem at all, most of these never did go any further. Buck W4TO was interested in another DXpedition since he had handled the QSL cards for the first trip. I visited him over in Atlanta a few times, and after seeing what a busy fellow Buck was with all of his irons in the fire I came to the conclusion that Buck just could not spare the necessary time to get things underway again. About this time I received a telephone call from Ack W4ECI saying he was interested in taking up the chores involved in a DXpedition of major proportions. We spent many many hours with each other with quite a number of trips to Birmingham thrown in. This trip we wanted to be the real thing, we did not want any stumbling blocks in our way and we wanted this to be a smooth operation all the way. I had met any number of fellows who were interested in helping on a new DXpedition in many different ways. A number of fellows furnished me with some AM phone rigs and others furnished me with small power plants to sort of open the doors to the islands in the Indian Ocean area. Others furnished items that were badly needed by the fellows up in the Himalaya kingdoms, there were many people to write letters to so they would be ready for me when I arrived in their part of the world. I suppose all together 25 or more fellows helped me in many different ways and it was a very fine feeling to know that so many of the fellows were behind me on that trip. I don't think there will ever be such a trip that began with the boys sticking with me and Ack as good as that one. Everything went so smoothly all during the trip, thanks to all the planning by everyone. Even after the trip had been finished I never have heard any real complaints from anyone for being apparently deliberately not worked like sometimes they seem to be on some DXpeditions. My motto was work everyone heard, regardless of who they were or where they were located. This is even now still my motto and it will never change. I have been on the DX from both ends for quite a number of years now and I know how the boys back here are sweating it out and how easy it is for them to misunderstand instructions given over the air with the QRM like it is most of the time.

I was advised by many fellows to put off any further plans for any DXpeditions until the Sun spot situation improved, possibly they were right. But my viewpoint was why wait until later on when all the boys were so eager for the DXpedition to take place now. My policy has always been to strike when the iron was hot, and right then it was about as hot as it would ever be. I looked back in my log books at the last sunspot minimum and by looking at the log I would never have known there was a minimum if I was trying to find it by looking at my logs. Considering the number of QSO's I had during the trip I don't think there would have been many more if the sun spots were at their peak. Of course they certainly did affect the 15 and 10 meter contacts and 20 was open for shorter periods of time. But you know a fellow has to sleep sometimes and with the bands closing somewhat earlier than they would have been with a good sunspot count I did at least get a chance to sleep sometime. But both Ack and I thought it was worth a try and we continued our plans regardless of the mood of the sun.

When Ack and I sent out some copies of our plans as to where we were planning on operating from I heard many remarks over the air from some of the boys such as: "Gus and Ack are dreaming," "this DXpedition will end in less than 3 months," "who do they think they are fooling," "this is a big joke," etc., etc. Well I think Ack and I fooled these fellows. Do you think I made a list of some of the stations making these remarks that I heard over the air? I certainly did not, but it would have made up a dandy little black list I guess. I am certain I left home on the trip I did not think it would ever be completed 100% as it was planned from the beginning. We were both very much surprised that it was concluded as well as it was. I did operate from many places I thought I would never operate from and I will admit I missed a few I thought I would get to. Things don't ever work out exactly like they were planned, at least not with me. When you leave the U.S.A. your plans have to be changed all the time. That is the way things are in the world and I suppose that's the way they will always be.

But it does make things a little bit more interesting I suppose. A surprise here and there makes life interesting I guess.

Wouldn't it be great to go on a DXpedition some day with no plans whatsoever as to where you are going? Maybe one of these days there will be some Sugar-Daddy who will hand me an airline credit card, and a few handfuls of American Express money orders with instructions to just go where you want to go and operate as long as there is pile ups, and then go to some other spot and do the same and to just keep going as long as you like. Boy that would be the DXpeditioners Dream, wouldn't it?

Everything was going along fine with the plans and there was lots to do before I left the USA. Two full days were spent in Washington, D.C., getting visas for the countries I wanted to go to. Then there were all the health shots. Some of the vaccine could not be obtained here in Orangeburg, S.C., and had to be ordered from a larger city. I have forgotten the exact number of shots I had to take, but I felt like a porcupine for about three weeks. In the end I think all these shots did me a lot of good and probably prevented me from picking up a lot of bugs here and there. I am sure something or someone protected me from all the bugs I was exposed to in all the different places I have visited. Something also protected me from stomach disorders I am sure because it was my rule to eat whatever was served me. I used to sort of worry about drinking water, but to this day I have never boiled any before I drank it. On my last trip I did have some of those little pills to put in drinking water to purify it, I think I used maybe one dozen of these pills on the entire trip. I usually gave them to some of the natives to use, explaining what they were supposed to do. I have found that any kind of medicine is always very welcome in almost any country in the world and is usually a good item to use to sort of get them to open their doors to you.

If when you go to Washington, D.C. to get your visas and if you have plenty of time to spend up there you can usually get a good letter of introduction from them (an ambassador's letter is the best) to their Minister of Communications. If you can just once get to see the Minister of Communications in a country and if you say the right things to him and can convince him that you are trying to help their communications you are then in, because he is the man who eventually will make the decision as to whether you operate there or not. A lot of red tape can be saved by seeing the minister himself first. He in turn will usually call one of his head men and let him take over. If the minister says, "go," you are all set and no one can upset your applecart. If I ever go on another DXpedition I want to spend maybe two full weeks in Washington visiting the ambassadors of the countries I want to operate from, with a good letter of introduction from a few U.S. Senators to him and if you are going to Moslem countries, a letter from your church minister if you are a Protestant or Catholic. If you are Jewish stay where you are . . . A letter telling that you are a good, upright citizen from your chief of police helps a little also. Be sure it's written on the Police Department's stationery. If possible have a few Zippo lighters to pass out or if you are well fixed pass out a Parker 51 here and there. I have yet to see the opening where a direct bribe would have done the job, with one exception, and this one wanted $1,000 to open the door and we still have about 4,000 or 5,000 QSL cards for that proposed stop—We counted our chickens before the eggs were hatched.

As a final send off Ack and I were at the Side Band Dinner in New York City and after that it was out to Idlewild airport and on the way to just about the best DXpedition I think there ever will be. We had to buy in New York at the last minute a new power plant because we found out that all the equipment etc. we had shipped many months before were held up somewhere along the way to the Seychelles on account of a strike. This meant much more expenses in air freight. The power plant was shipped to Bombay, to be transhipped on to the Seychelles on the same boat I was going on. ADVICE to the DXpeditioner, be prepared for unexpected financial burdens, because they are always turning up when least expected. I suggest you figure what your trip will cost, taking everything you can think of under consideration and then add about 50% to your figures and you MIGHT come out OK (if you are very careful, that is).

As a sort of warm up practice run and to let the boys know I was on my way I stopped in Monaco for a few days operation after a very short trip around portions of Europe. To the Hotel La Seicle in Monaco I went and as usual checked into the room they seem to hold for DXpeditioners (room #40), up went my antennas and the DXpedition was officially underway. This time I was a little bit better prepared and instead of the KWM-2 and the outboard VFO I had the "S" Line but only barefoot. As usual the very first night at about 2 AM, just like before the filter con-

densers in the PM-2 power pack blew up on account of that high line voltage, but this time I had brought some 600 volt filters along with me, after substituting these for the 450 volt jobs in the power pack my filter condenser troubles were eliminated for the balance of the trip.

Also I found that the power transformers get awful hot, and I would further recommend that you drill a great many holes all around it and bring along a good electric fan to make it run cooler. Everyone tells me these transformers are made to take a lot of heat—but I like for them to at least be cool enough to put your hand on them without getting burned. A little breeze from the same fan around the final tubes certainly would not do any harm either. I am not much afraid of the heat from the tubes hurting them as I am from the heat doing damage to some of the other components. I think most of the ham transmitters on the market today are FB if they are used, lets say, for a few hours every day, but I don't think they are made to stand, say, 18 to 20 hours duty at a time, especially if the line voltage is on the high side and the cycles are 50 instead of 60 like we have here in the USA. It's 50 cycles practically everywhere. If your travel expense can stand a little extra weight I highly recommend that you take with you a Powerstat that will operate from both 240 and 120 volts, with a built in voltmeter and a knob that's real handy to regulate the voltage. Let the equipment operate on 120 volts but have your Powerstat so that it can be changed from 120 to 240 volts easily without a soldering iron. Your little soldering iron can be a 120 volt one since you will have 120 available at all times by using the Powerstat. Remember you just cannot find 3-way plugs overseas, not of the type we use over here, so bring along a few of these, you can use them in all of your connections EXCEPT the connections to the power source. These oversea plugs can be of almost any size or shape and it's practically impossible to have along with you a universal plug to fit them all. They can usually be bought overseas quite easily though, I myself have found that one set of your Powerstat wires should end up with a pair of Alligator clips on them, these clipped on a piece of solder can be made to fit almost anything you run into. Don't overload yourself with a big box of spare parts, because even then nine out of ten times you will still not have what you need in case you really get into serious rig trouble. . . . Gus

Paul Franson WA1CCH
Peterborough, N.H.

Guide to Surplus Conversions

Many articles have been written—and published—about surplus. These articles have ranged from simple suggestions to complete and detailed conversions such as the one by WA6BSO in this issue of 73. But these conversions are often hard to find; this is well demonstrated by the many articles on surplus that are duplications of other articles.

But it's not really that hard to find surplus conversions. Roy Pafenberg W4WKM has compiled a list of all the conversions he could find in the popular electronics magazines since World War II in the *Index to Surplus* available from many distributors or 73 for $1.50. But the *Index* does not list the articles that have appeared in the various surplus *handbooks* that have been published. That's what this article is for. I've listed the pieces of equipment covered in the six surplus radio handbooks now available. The conversions differ greatly in completeness, so it's suggested that you take a look at any books of interest before you make big plans.

Editors and Engineers

Editors and Engineers, P.O. Box 68003, New Augusta, Indiana, have published three *Surplus Radio Conversion Manuals* by Evenson and Beach and the *Surplus Handbook, Vol. I* by W6NJV and W6NJE. Each costs $3. Here are the pieces of equipment covered in each manual:

Surplus Radio Conversion Manual, Vol. I. BC-221, BC-342, BC-312, BC-348, BC-412, BC-645, BC-646, SCR-274 (BC-453A and BC-457A series), SCR-522, TBY, PE-103A, BC-1068A/1161A.

Surplus Radio Conversion Manual, Vol. II. BC-454, AN/APS-13, BC-457, ARC-5, GO-9/TBW, BC-946B, BC-375, LM, TA-12B, AN/ART-13, AVT-112A, AM-26/AIC, ARB.

Surplus Radio Conversion Manual, Vol. III. APN-1, APN-4, ARC-4, ARC-5, ART-13, BC-191, BC-312, BC-342, BC-348, BC-375, BC-442, BC-453, BC-455, BC-456-9, BC-603, BC-624, BC-696, BC-1066, BC-1253, CBY-5200, COL-43065, CRC-7, DM-34, DY-2, DY-8, FT-241A, MD-7/ARC-5, R-9/APN-4, R-28/ARC-5, RM-52-53, RT-19/ARC-4, RT-159, SCR-274N, SCR-508, SCR-522, SCR-528, SCR-538, T-15 to T-23/ARC-5, URC-4, WE701A.

Surplus Handbook, Vol I. This book, subtitled, *Receivers and Transceivers*, is composed of schematics and pictures of the following gear. It doesn't give conversions. APN-1, APS-13, ARB, ARC-4, LF and VHF ARC-5, ARN-5, ARR-2, ASB-7, BC-222, BC-312, BC-314, BC-342, BC-344, BC-348, BC-603, BC-611, BC-624 (SCR-522), BC-652, BC-654, BC-659, BC-669, BC-683, BC-728, BC-745, BC-764, BC-779, BC-794, BC-923, BC-1000, BC-1004, BC-1066, BC-1206, BC-1306, BC-1335, BC-AR-231, CRC-7, DAK-3, GF-11, Mark II, MN-26, RAK-5, RAX, RAL-5, Super Pro, TBY, TCS, VT tube cross index.

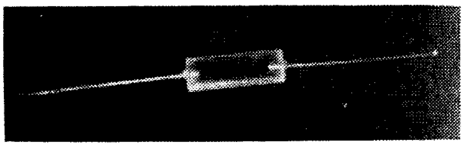
CQ Handbooks

CQ has two handbooks on surplus out. They can be ordered from CQ, 14 Vanderventer Avenue, Port Washington, N.Y. The first book, the *Surplus Schematics Handbook*, by Ken Grayson W2HDM, costs $2.50, and contains schematics and short comments about this gear: APA-38, APN-1, APR-1, APR-2, APS-13, ARB, ARC-1, ARC-3, ARC-4, ARC-5, ARC-5 VHF, ARJ-ARK-ATJ, ARN-7, ARR-2, ART-13, ASB, AS-81-GR, ATK, BC-AR-231, BC-189, BC-191, BC-221, BC-312, BC-314, BC-342, BC-344, BC-348, BC-375, BC-438, BC-474A, BC-603, BC-610, BC-611, BC-620, BC-640, BC-645, BC-652, BC-653, BC-659, BC-683, BC-684, BC-728, BC-733, BC-745, BC-779, BC-794, BC-906, BC-969, BC-1000, BC-1004, BC-1023, BC-1206, BC-1335, BN, BP, C3, CRC-7, CRO-208, CRT-3, DAE, F3, GF-11, GO-9, GRR-5, I-122, I-177, I-208, JT-350A, LM, Mark II, MD-7, MN-26, PRC-6, PRS-3, R-174, RAK, RAL, RAO-7, RAS, RAX, RBH, RBL, RBM, RBS, RC-56, RC-57, RDC, RDR, RDZ, RU-16, SCR-274, SCR-284,

SCR-288, SCR-300, SCR-506, SCR-522, SCR-578, SCR-585, SCR-593, SCR-608, SCR-610, SCR-624, SCR-628, SPR-1, SPR-2, TBS, TBW, TBX, TBY, TCK, TCS, TG-34, TS-34/AP, TS-251/UP, VRC, VVX-1.

The other CQ book, the *Surplus Conversion Handbook* by Tom Kneitel K3FLL, ($3) contains conversion on these pieces of gear: ARC-1, ARC-3 , ARC-4, ARC-5, ARC-36, ARC-49, ART-13, ATA, ATC-1, BC-191F, BC-224, BC-312, BC-314, BC-343, BC-344, BC-348, BC-375E, BC-453, BC-454, BC-455, BC-457A, BC-458A, BC-459A, BC-603, BC-604, BC-620, BC-624A, BC-625A, BC-659, BC-669, BC-683, BC-684, BC-696A, BC-779, BC-794, BC-946, BC-1004, BC-1068A, CBY-52232, PE-73, PE-103, R-129/U, RAX-1, SCR-177, SCR-188, SCR-193, SCR-274N, SCR-399, SCR-499, SCR-508, SCR-509, SCR-510, SCR-522, SCR-528, SCR-542, SCR-608, SCR-609, SCR-628.

. . . WA1CCH



Cheap Coil or Choke Forms

Not liking to pay the price for Z-144's, I consulted the May '62 issue of 73, page 99, to obtain data for a 2 meter choke coil. The form size specified was 5⁄16 inch, not a standard size around my shack. The cost of commercial forms of this size was out of the question (when you're as Scotch as I am). Next step: take a 5⁄16 inch diameter polystyrene rod and cut a section to required length for winding the choke.

To make the form, prepare polystyrene rod as shown in the photo. Then hold section of polystyrene rod in vise or some other secure manner. Now take lengths of #18 or #20 wire, depending on strength desired in the leads. Place length of wire against end of polystyrene rod in center, carefully apply enough heat with soldering iron to cause the wire to penetrate deep enough into the polystyrene rod for good mechanical strength, then remove heat and let set. Repeat for other end.

After both lengths of wire are firmly set, wind desired choke. Care should be exercised in soldering coil wire to wire leads. A heat sink is recommended to avoid excessive movement of leads.

This inexpensive method of making rf chokes is used quite successfully at my QTH.

. . . Gary Smith WAØASA

NEWS FROM THE INSTITUTE OF AMATEUR RADIO

Compiled by A. David Middelton W7ZC, Secretary

IOAR emphasis now and for the future

The following material has been carefully documented—in depth, to include the aims, goals and purposes of the Institute. Many of these are goals to be reached in the future when sufficient membership, support and money are available. Many projects are currently active and more are being implemented.

The Institute intends to emphasize individual effort along technological lines and point up self-incentiveness and achievement of the individual operator.

The Institute will recognize and award appropriate citations to group activities that are deemed above and beyond those normally found in amateur radio circles.

Those activities that have been recognized and rewarded (by various certificates etc.) by other organizations are not to be ignored or overlooked. However, the IoAR will seek out the unusual, the hitherto un-noticed activities in many areas to bring such performances to the attention of the entire amateur body and to the public whenever possible.

The Institute is cognizant of the inevitable—the fact that international conferences, within the next few years, will likely bring radical and disasterous changes in our operation thru the reduction, sharing or even the demise of our currently available lower frequency bands.

The IoAR holds the opinion that amateur radio will survive such a catastrophe, although *AR as we know it now may pass from the scene.*

Therefore, the IoAR will emphasize a completely NEW concept of amateur radio, in which VHF and UHF, through the use of direct, relays or satellite QSOs will expand our horizon and permit AR operation on a scale even greater than now realized!

Amateur radio survived ignominious relagation to "below 200 meters". AR survived segregation into "bands" . AR survived when all foreign and domestic operation was dumped into what were then very narrow bands (considering the expansive areas previously available). AR survived the BCI and the TVI wars that threatened our very existence. (Note—The TVI war is not over yet and now an even greater danger looms—the zoning—deed—restrictions on towers and antennas that are *increasing!*)

AR, so far, has even survived the so-called "appliance-type" operation by turning some of these "appliances" into useful instruments of service to the non-amateur public in emergency, priority, and routine networks of various styles and degrees of value. Mobile operation has been a boon!

Amateur radio, the Institute believes, may survive the drastic changes that will be brought about by international conferences. The IoAR believes that AR will *only* survive (after the roof falls in on our so-called DX bands) by our thorough knowledge and utilization of the VHF and UHF we now have (and which are likely to hold onto) those expansive frequencies above 144 MHz.

This implies knowledge and utilization of techniques with high-performance stations, with relay and satellite assists. It also implies more do-it-yourself technical hamming and more know how!

If the amateurs (and the commercial manufacturers) keep up with these trends and provide equipment suitable for such applications, AR will be greater than ever.

IoAR believes that VHF provides an excellent place for the new amateur, if he is willing to study, read, learn technique, and to observe what others have and are doing.

Amateur radio can survive! There is plenty to intrigue even the most blasé, if he will learn how to use AR, and learn the *technical* as well as the operational side. It is more fun to KNOW than to belittle your own ability by the "NOT KNOW" attitude so prevalent today!

FCC expands intent of 97.125

FCC Regulation 97.125 states—"*Interference:* No licensed radio operator shall willfully or maliciously interfere with or cause interference to any radio communication or signal."

On Feb. 4, 1966, the FCC issued their expanded interpretation of 97.125, as follows:

"This letter will advise you of the Commission's rules and policies applicable to general interference between stations licensed to operate in the amateur radio service.

"As you are undoubtedly aware, frequencies allocated to the amateur radio service must be shared by all licensees. Consequently, interference between stations is most likely to occur during periods of heavy activity on, and occupancy of, an amateur frequency band. Experienced amateur operators are expected to anticipate and minimize this interference. Their failure to do so indicates either ignorance of the practical realities of amateur communications or a selfish lack of consideration for others. Assuming that it is your desire to alleviate interference between amateur stations, the following guidelines and considerations are presented.

"Licensees of stations which are already in op-

IoAR—Totally Dedicated to the Betterment and Preservation of Amateur Radio.

eration should remember that no amateur licensees, group, or network has a right to the priority or exclusive use of a given frequency nor may freedom from interference be expected (exception is provided under the emergency provisions of rule Section 97.107). In addition, common courtesy, as well as good amateur practice, dictate that incessant or continuous non-emergency operation so as to preclude others from operating is highly undesirable and unwarranted and, if willful or malicious, could result in the imposition of punitive measures.

"Licensees of stations who are attempting to utilize an occupied frequency should note that Section 97.125 of the rules provides that: No licensed radio operator shall willfully or maliciously interfere with or cause interference to any radio communication or signal." Moreover, observance of good amateur practice requires the avoidance of attempting operation on a frequency where it is obvious or likely that such operation will result in harmful interference.

"All licensees should avoid the following frequently observed improper practices, some of which constitute willful interference for which severe penalty is provided:

"A. Knowing and repeated operation on, or unreasonably close to, a net frequency at times when the net is obviously active;

B. Requesting or demanding protection of a net frequency at times when the net is inactive;

C. Requesting or demanding protection of a net frequency over a long period of time in the absence of an emergency situation;

D. Calling, testing or tuning on a frequency without first determining that the frequency is not already being used;

E. Carrying on an exchange of communications on two (or more) separate frequencies when there is no technical or operational necessity for such muti-frequency usuage.

"As noted, the foregoing is furnished for your guidance. From long experience, the Commission has found that in most instances neither party to an incident of alleged deliberate interference in the use of frequencies is entirely blameless. The keynote to resolution of these interference problems, therefore, is cooperation and consideration by all persons involved.

"You are permitted and encouraged to read and discuss this letter via your amateur station. You may be assured that any effort on your part to contribute to better amateur radio practices and operations will be greatly appreciated.

"Very truly yours,
S/ Ben F. Waple
Secretary"

Attention—young IOAR members

In keeping with IoAR's program for advancement in amateur radio through individual achievement IoAR emphasizes a building-writing contest—open ***only*** **to IoAR members whose birthdate falls after July 15, 1946.**

Important IoAR Addresses

For all correspondence except that regarding membership and supplies:
Institute of Amateur Radio
Springdale, Utah 84767

For membership correspondence and IoAR supplies:
Institute of Amateur Radio
Peterborough, N.H. 03458

First Prize—a $25 Savings Bond, and publication at space rates in 73, for the best construction article for an original piece of AR equipment having at least *five* tubes or transistors.

Second Prize—a $15 Gift certificate, (good toward the purchase of any 73-advertised merchandise) and publication at space rates in 73 for the best construction-article on an original piece of AR equipment having at least *three* tubes or transistors.

Third Prize—a $10 Gift certificate and publication at space rates in 73, for the best construction article on an original piece of AR equipment having less than three tubes or transistors.

All design, construction, photographs and text material must describe only original equipment. Entries must not be copied from articles or equipment in any magazine or handbook. Kit construction or modifications, in any form, are not eligible.

All material submitted will be considered by competent IoAR selected judges. Their decision will be final. Certification of contestant's birthdate may be required by the judges. IoAR membership will be checked by the IoAR membership dept. No correspondence will be conducted by IoAR HQ regarding this contest.

Non-winning entries will be returned only if accompanied by adequate first class postage.

To be eligible for this contest, entries must be received not later than July 15, 1966, at IoAR HQ.

IoAR "Who, What and Why"

The Institue's new 16-page informative booklet is now available!

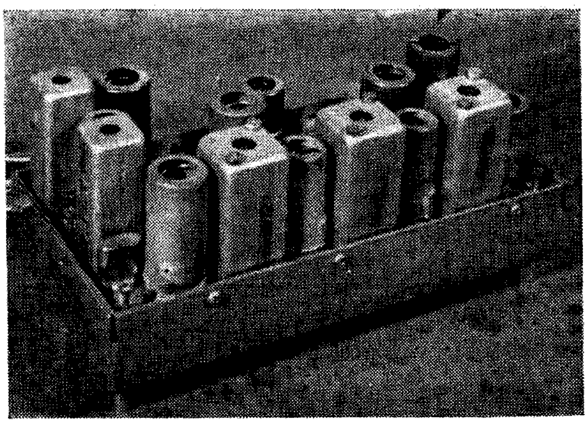
There have been many requests for a comprehensive booklet covering the aims, goals and projects of the IoAR.

Although prepared for study by non-members it also provides a useful "tool in a member's hands when asked—who, what or why is IoAR?

If you would like a copy or copies (in limited quantities) please advise IoAR HQ giving your complete mail address, and accompany your request with an unused 5¢ USA stamp for *each* copy requested.

Lost IoAR members—QTH?

Mishou, Edward C WA5DRU
Coldsby, Edward DL4UC
Shepard, Richard WAØJRE
Please send updated QTH to IoAR HQ.



The ARC-27 guard receiver.

A schematic of the ARC-27 is available from 73 for 50¢

Joseph Hinkelman K3CES
4708 Hillside Rd.
Harrisburg, Pa. 17109

220 mc Receiver from the ARC-27

With the appearance of the ARC-27 on the surplus market more articles are being written every week, about this versatile piece of equipment. The RT-178/ARC-27 is composed of ten different subassemblies all are the plug in type.

The one we are interested in is the Guard Receiver sub-assembly. Each unit is marked making identification easy. The Guard Channel Receiver is a dual conversion superheterodyne receiver with a 19.4 mc first if, and a 3.45 mc second if. The guard channel receiver also incorporates a separate detector, noise limiter and avc section has its own squelch circuit, sensitivity control and audio gain control. The receiver is crystal controlled making it useful for net and MARS operations. The original frequency of the receiver was from 238 mc to 248 mc. A few simple modifications will bring it down to 220 mc to 230 mc.

Modification of unit

Step one will require converting the filaments to 6.3 volt operation. Fig. 1 shows the original series-parallel circuit that was used with this equipment. Pins 13-10-8 of J-810 will be tied together to the 6.3 v. input. The existing wires may be used by carefully cutting the wires and rerouting it to the necessary socket pins.

Step two in the RF section will be very simple. Coils L-803, L-804 and L-802 can be brought down to 220 mc, simply by squeezing them together. They are marked on the subassembly. A grid dip meter should be used to bring the coils within the proper range.

Step three will require the modification of the First Injection Oscillator. It is this stage that will determine your operating frequency. Xtal Y-801 will have to be changed to whatever frequency in the 220 mc band you wish to operate in. A 33.44 mc xtal will give you a operating frequency of 220.04 mc. The following formula will help in selecting the proper operating xtal

$$\frac{\text{operating freq. desired in mc } 19.4-}{6} = \text{input xtal freq.}$$

You may have to add small capacitors across each coil to bring them down to the proper frequency.

Pin connections to J-810 are as follows: 5 is the sensitivity control lead. Use a 5000 ohm pot to ground. 15 is ground. 3, 4, 7, 9, and 14 are not connected to anything. 1 is −80 volts bias. 6 is +225 volts. 2 is for squelch, use a 25 k pot in parallel to .1 µf capacitor for it. 11 is audio output. The filament connections are shown in Fig. 1.

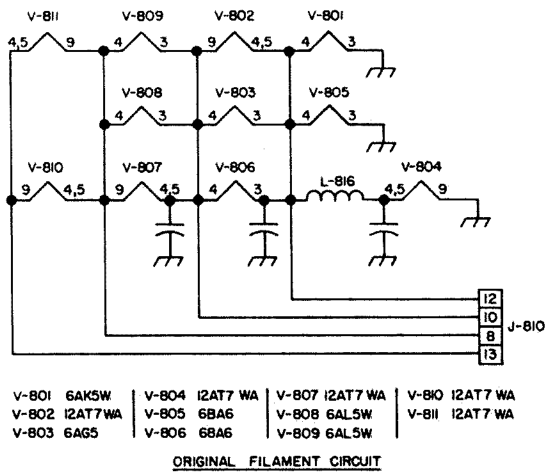


Fig. 1. Original filament circuit.

The builder may use whatever he may have available in power supplies. The B+ should be 225 volts at 100 ma, and a bias voltage of −80 volts is needed. The filaments will require 6.3 volts at 3 amps.

Tuning and operation

After the RF stages and first injection oscillator have been tuned to their approximate frequency, power should then be turned on. After a smoke test the oscillator should be checked to see that oscillation is taking place. A GDO can be used for this operation or a sensitive wave meter by close coupling to the oscillator tube (V-807). After the oscillator section is working properly a signal generator should be used to peak up the RF section. If no signal generator is available couple an antenna to J-801 and starting with C-811 cap. peak up on the noise then proceed to C-810 doing the same. Last the antenna section should be peaked with variable cap. C-803.

If speaker operation is desired an additional stage of audio will be needed which can be built into the power supply. The author has experienced no difficulty with this unit. Signal results are very good, and with xtal operation no drift was noticeable.

. . . K3CES

George Allen K1EUJ
74 Wells St.
Westerly, Rhode Island

BC-453 Series Receivers

Simplest Conversion

The BC-453 series receivers can still be obtained from surplus houses or the junkboxes of neighboring hams. This series receiver, while not very selective, is still quite useable as a regular ham band receiver (when the bands aren't too crowded), or as a receiver used in conjunction with an hf of vhf converter. There have been several published conversions for this receiver; however, most of these are involved and do more than just get these receivers working. This article describes a very simple, step-by-step conversion process which will get this receiver operating into a pair of earphones inside two hours, provided you have an available power supply.

The conversion process described in this article was developed and tested on several BC-454 receivers; however, the instructions also apply to the BC-453 (190-550 kc), the BC-455 (6-9 mc), and the BC-946B (520-1500 kc).

Filament conversion

Refer to **Fig.** 1 to make the following conversion steps to put the filaments in parallel.

Step 1—Remove bottom plate from receiver.

Step 2—Unscrew the capacitors above sockets B, E, and F in order to gain access to the tube sockets.

Step 3—Observe wire running from pin 7 of socket A to pin 2 of F. Disconnect this wire from pin 2 of F and connect to pin 7 of F.

Step 4—Observe wire running from pin 7 of C to pin 7 of E. Disconnect from pin 7 of E and connect to pin 2 of E. Ground pin 7 of E.

Step 5—Remove the wire running from pin 2 of D to pin 7 of B. Ground pin 2 of D. Run new wire from pin 7 of D to pin 7 of B.

All of the filaments are now in parallel.

George was formerly W3ZIG. He's a physicist (B.S. Muhlenberg) with General Dynamics/ Electric Boat and has published a book "The Asian Tide and Other Poems."

Step 6—Screw the capacitors back in place and put the bottom plate back on.

Wiring front panel adapter

The following parts will be needed to complete the conversion: 1-s.p.s.t. toggle switch for bfo switch, 1-earphone jack, 1-small 20 k pot. (anything between 5 k and 50 k will work) this pot must be physically small so it can be mounted on front cover plate.

Step 7—Remove small cover plate from the front panel of the receiver. Remove the female plug from this cover and discard.

Step 8—Drill this cover plate to take the jack, switch, and pot. (no parts layout is given for this step since it is assumed junkbox parts will be used. Needless to say, junkbox parts vary considerably.)

Step 9—Make the connections as shown in **Fig. 2** by soldering directly to the exposed pins.

Step 10—Screw the cover plate back on to the receiver being careful not to short the components on the cover plate.

Power connections

Fig. 3 shows the power connections to be made to the dynamotor socket on the top-rear of the receiver. If your receiver still has the dynamotor attached, remove it completely and add it to the junk box. B plus voltage of 100 to 220 volts may be used. I use a B+ voltage

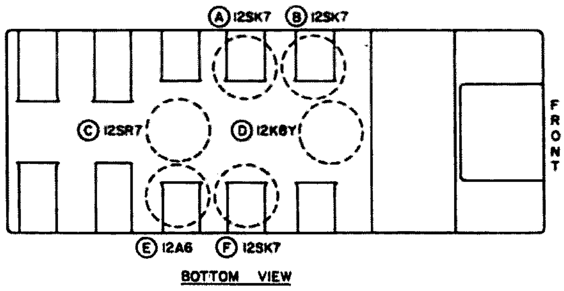


Fig. 1. Location of parts of the BC-453 series receivers.

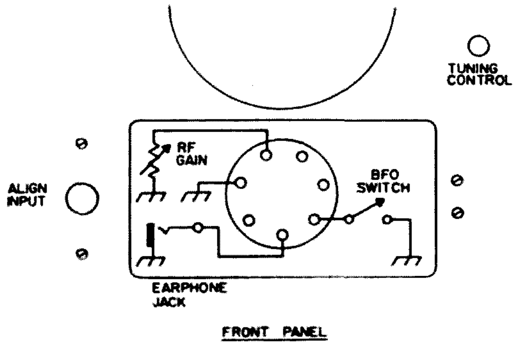


Fig. 2. Connections to the front panel plug.

of 180 v and get excellent results. If you have 12v filament voltage available (ac or dc), you may use the tubes supplied with the receiver, however, if you only have 6 v filament voltage, it will be necessary to make the following tube replacements:

Replace 12SK7 by 6SK7
Replace 12A6 by 6K6
Replace 12SR7 by 6SQ7
Replace 12K8Y by 6K8

Operation

Connect a set of headphones to the jack installed on the front panel, connect any antenna to the antenna jack, hook up a power supply and you're ready to go. Adjust the pot (the rf gain control) to a comfortable listening level, peak the "align input" control to maximum volume and then readjust the rf gain control.

When I converted my BC-454, I was a bit dismayed to discover that I had no tuning knob for the receiver. I did, however, have a few scraps of old rubber tubing of $\frac{3}{16}$ inch inside diameter. Tubing of this size slips easily over the tuning gear and makes an excellent tuning device.

The receiver as it stands with the 6 or 12 volt set of tubes is quite sensitive; however, additional sensitivity may be obtained with 6 v tubes by replacing the 6SK7's by surplus 717A's.

. . . K1EVJ

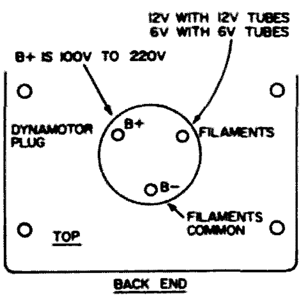


Fig. 3. Power connections to the receiver.

advised by my lawyers that
don't you ever proofread y
are a bunch of crooks and
this is the last straw for
have no other recourse but
should be tarred and feath

Letters

Dear 73:

I've had many requests for help from USA amateurs concerning putting 12 volts in VW's as in my article in the March 73. A new possibility is a three phase generator for the VW 1200 and 1300. It is made by Bosch and is shorter than the traditional generators so can be mounted without altering the hitter-system. You can buy the necessary fittings from Bosch. If you want to make your whole car 12 volts, you must not break up the 6 volt generator or the fan of the air cooling system would not be driven.

I will gladly be of help in supplying the parts.

Hein Ahlers DJ2UL
Oldenburg, Germany

Dear 73:

There will be a Korean QSO Party from 2400 GMT 2 July 66 until 2400 GMT 4 July 66. Present plans call for maximum participation from the HL9's and it is hoped that the HM's will also participate. The party will be held on all bands and all modes.

An appropriate award will be made to the station outside Korea submitting logs with the most HL9 and HM contacts during this period. Logs should be sent to Eight Army Radio Club, Electronics Craft Shop, 19th General Support Group, APO San Francisco 96301.

So here's a chance to get Korea for that DXCC and also a chance to get the Kimchi Award sponsored by the Eight Army Radio Club.

Martin L. Smedley WA3ERL
Sec/Treas
Eight US Army Radio Club

Dear Wayne:

I just received the April issue of QST and turned to the Sweepstakes results. I feverishly searched for my score as this was my first SS. Seventh in L.A., not bad. As I looked over the other scores I was astonished by the obvious and flagrant cheating most section winners displayed in submitting their power multiplier. It seems mine is the only station placing in the top ten in L.A. using over 150 watts input. Disregarding that, I know for a fact that this is not true. It must be obvious to any contest participant that it is almost impossible to rack up a huge score using low power. You cannot control a frequency using under 150 watts in the heat of the contest. I feel especially sorry for those stations who accurately reported their score only to be pushed out of a section win by a ham who lied about his power. This practice induces those who wish to be honest to cheat so that they may compete on the same standard as the big guns. The ARRL obviously recognizes the situation and by their silence sanctions this practice. Wayne, take over now.

Ken Feldman WB6FRP
Los Angeles, California

Alas Ken, many of us have been asking that this stupid rule of the Sweepstakes be changed for many years, but to no avail. It has always been that way and I suppose it always will be. In my first SS participation, back in 1941, 25 years ago, the complaint was the same. Virtually all of the winners had to cheat to win. Great for the sport, eh?

It was difficult to figure out from the mish-mash report in QST on the 1965 Sweepstakes, but, neglecting that finky power multiplier, it looks as if WA4NGO in Florida with 926 contacts in 73 sections was first and W2NSD/1 in New Hampshire with 823 contacts in 73 sections was second. And I'm embarrassed for the League and the 16 other "winners" who claimed they were using under 150 watts and took the multiplier. Ken, we all know how much power these fellows were running.

Dear Wayne,

Can you or anybody else tell me why in the name of statistics do we have to have forty-eight hours of DX contest on the weekends?

There is enough activity going on during a normal weekend to prove most anything; furthermore, DX operation of the rag-chewing variety gives a more concrete idea how good the equipment and band conditions are. *If it* is necessary to gather statistics to prove that the amateur bands are overcrowded, I would say that a mid-week contest would be far more convincing, because there would have to be some sacrifice on the part of the participants whose free time normally falls on the weekends.

I think that these two day contests are in poorer taste than the DXpeditions. Granted that everyone likes to work a new QTH, but just what a fleeting period of operation in another wise non-communicative location proves, except that there are no radio deadspots, is more than I can see. If the time and money spent for these expeditions was contributed to the establishment of an amateur club among the inhabitants of these regions, then there would be some lasting benefit to world-wide amateur radio. What do you say?

Herbert Heath, Sr. DJØKK

April Issue

It's a bit hard to print, but WØAIO apparently didn't like Annie, so he sent us a skunk along with the Annie torn out of his GC. *Paul.*

Dear 73:

Today I received my April 73. Congratulations to you and Wayne Pierce on a job well done. For next year how about a foldout of a . . . well . . . uh . . . you know . . .

John Hall WN2UHK
Hornell, N.Y.

PS. I'm a minor, so please send future issues in an unmarked wrapper.

Dear 73:

Please rush me another copy of the April 73. Some *#%&@¢ stole the centerfold from mine.

Nemo

Dear Paul:

73 arrived today. Noting the cover, quickly turned to the center page fold-out of a bare foot VOA transmitter. But it wasn't there.

Think the short note about the author of some articles is very good. Let us know who the authors are.

Dave WA9BQQ
Chicago, Illinois

Dear Sir:

Just received the very mediocre April 73.

You must really be hard up for articles and useful information.

After looking at the (CENSORED) [sic] on pages 124, 125 and 126, will you please reconsider? If you can't come up with anything better than that, please leave three pages blank so I can at least use them for scratch paper.

W. A. Sayles

Dear Paul:

Re your question on comments about the contents of 73 in April.

Only a CB column is missing to make 73 jack of all and master of none. Pages 51 [Ham Word Play] and 124 [Annie] stink, 38, 80 and 86 are very good and 7 is juvenile. 82 and diode checker are out of CQ and QST.

All in all 73 is not too bad even if Wayne always wants help or money for his projects; he is as bad as I am but then he does not like me anyway.

VE6TW

Thanks for your comments. Wayne says he doesn't even know you. How can he dislike you? Paul

Standard Frequencies

Dear 73:

"Standard Frequencies," a short article in September 1965 73 said ". . . 1000 cycles (is available) from the telephone company by dialing any local exchange followed by 9945." It should have added "in the New York City area." Apparently each Bell Telephone division has a different number for its 1000 cycle test tone. In the Minneapolis-St. Paul area it is any exchange followed by 4098. Telephone companies are reluctant to reveal the number for fear of overloading the line power-wise, but a little serious spade work will turn it up. I was able to compare the Minnesota and New York City tones with a telephone on each ear, and the tones were identical, so apparently they are extremely accurate as to frequency.

Robert Kuehn WØHKF
West St. Paul, Minn.

Dear 73:

The need for well organized traffic nets on the VHF frequencies is here. One good example of this was the recent blackout in New England, which I understand was handled quite well by the VHF boys in that area. I feel that the amateurs don't realize the importance of these nets until a crisis hits their area and then it's too late to think about organizing a traffic net. We are a group of well trained individuals who could, given leadership and time, set up one of the finest emergency nets ever dreamed of. I am speaking of the amateur who is on the VHF frequencies. There is a need! Over 300 disasters occur in the U.S. every year and the next one could involve you and your loved ones. There are a number of these well organized groups in this country, but then there are others, like the North-South Carolina, Georgia sections that are lacking in emergency groups. Why does this situation exist? One good reason is the lack of activity. Night after night I can sit at the "rig" and hear no signals for 200 miles. Why can't we get the boys on the low bands to do their local rag chewing on 6 or 2 meters? They are crazy to try what they're doing on the 75 meter band: I'll tell you my explanation of the matter. These boys, for the most part, are scared to give it a try. They think that equipment is to hard to get or build. They also feel that there won't be enough people to talk to. These are good reasons on the surface, but when you get right down to fact, they hold no water. You put forth effort and some determination and these problems will no longer exist. If everyone would talk up VHF on the low bands and point out that there are many open frequencies . . . QRM FREE to rag chew on locally, then maybe more people would get on. I have heard too many "slams" against VHF and it hurts. "Sure I'm on 2 meters. I thought everyone was . . . at least all of us that have a telephone . . . ha ha." Or you might hear, "There sure is plenty of space on VHF. I was up there and listened for one whole week and heard no one . . . What did I have on 6? . . . Oh, a sixer into my ten-twenty-forty meter vertical. Sure loaded up good though . . ." What is wrong with these supposedly "skilled technicians"? Can't they read the instruction manual that clearly states that a good beam CUT TO FREQUENCY is needed for satisfactory results? We need more positive thinking towards these bands. If we are to use them for what they are best suited for, that being local QSO's and local traffic and emergencies!!! If more of the low band boys would talk up VHF, or better yet shut their mouths when they don't know anything about them, we would have more activity up on these blessed and peaceful bands . . . or maybe not. Nobody want to be alone. Over the past five years that I have been in S.C., I have heard many stations come and go on 6 and 2 meters. They don't stay, or they do so little operating that they might as well be gone.

The Greenville VHF Society has proposed a plan that might help matters in this area. We would like to form a loose federation of clubs in this Tri-State area (mainly the ones that are interested in VHF), and through this organization, form a well organized traffic net to bind the states together. Furthermore, an exchange of information between the clubs in the form of bulletins, newspapers and/or membership representation for lectures would keep the union alive. If the clubs would consent, an annual conference could be held at which time officers could be elected and at which, outstanding VHF men (such as yourself) and also representatives of manufacturing companies could come and lecture on VHF topics. This would be up to the individual clubs as the federation does not intend to change any of the basic or political structures of the "local club." The federation would be only a supplement or an aid to them.

Needless to say, it would take a lot of time and a great deal of work, but we are willing to take the first step in this matter only if we feel that others will take their share of the load. I have appointed the vice-president of the club to take over the program and to handle any correspondence that there might be. He will be more than happy to receive letters and comment both pro or con. Please address all correspondence to Ron Higgs, WA4ZBV, 106 Clarendon Dr., Clemson, S.C. 29631.

R. P. Gruickshank WA4LTS
President
Greenville S.C. VHF Society

DX Antennas

Dear Paul,

It seems that my article in the April 1966 issue of 73 ("A Look at Antennas for DX," p. 68) has stirred some measure of controversy among the DX fraternity. Letters which have come to me in the last two weeks have largely sought to differ with my statements as to the relative merits of vertical and horizontal polarization for long-distance propagation.

Before commenting on the arguments expressed in the letters, though, let's correct an ommission in the text of the article, as published. It looks as though the typesetter completely missed page 6 of the original typewritten manuscript. In the right-hand column of page 71 there appears a sentence which is partially in italics. This sentence is correct, but the next is not. To correct the article, *substitute all of the following for the incorrect sentence:*

The point of this is that an intelligent choice of antenna height consistent with **Figs.** 4 and 5 and your pocketbook will get you the best DX signal for the money you have.

Now let's talk about some specific antennas. If you have bought or built the tower that best fits your wallet and radiation angle requirements, it is time to find an antenna with the most gain and front-to-back ratio you can afford. Keep in mind that the radiation angle is almost completely established by the antenna height, not by the type of antenna, with the mild exception of the cubical quad, which will be discussed later.

Of course the cadillac of DX antennas is the rhombic, with the vee-beam a close second. If you can afford it, and have the space, put some up. The design tables are readily found in the handbooks. The average ham, however, must make up his mind between the various types of tower-mounted rotatable arrays. The most popular of these types are the Yagi and the quad, so let's compare the two.

Quad vs. Yagi

Perusal of the reams of information that has been written about the quad and Yagi arrays brings to light some interesting points of difference between the two. Probably the most important difference concerns the radiation angles obtainable from them. For heights greater than one-half wavelength **Fig.** 4 applies to the quad just like any other antenna. At a height of one-half wavelength or less, however, the quad produces slightly lower angle radiation than the Yagi will. (End correction)

Now in hopes of clearing up the questions posed by those interested enough to write letters, I will reiterate some of the points made in the article.

1. The real interest a DX man has in his antenna is in creating the maximum signal strength at the DX location. If his antenna does this while transmitting, it will also make a superior receiving antenna for listening. So the question resolves itself into this; which

polarization produces the maximum field strength at the distant location? The relative merit of an antenna to produce this distant field strength is evident in its vertical radiation pattern. The important considerations are the vertical angle of the lowest lobe; and the length of the lobe, which represents the field strength generated by the antenna. This disregards gain in the horizontal plane, of course.

2. For equal total antenna heights above average ground greater than one-half wavelength, the vertical and horizontal both produce roughly the same radiation angle at the usual DX frequencies. This assumes that the horizontal antenna is a half-wave dipole, and the vertical is composed of an array of half-wave dipoles arranged collinearly and fed in phase. But (although the radiation angles are about the same), *the horizontal will produce at least 3 db more signal strength in the lower lobe*. This is because horizontally polarized energy radiated nearly parallel to the earth's surface is more completely reflected than is vertically polarized energy.

3. It is true that continuing to stack collinear vertical dipoles to greater and greater heights will produce lower and lower radiation angles. But due to poor reflection characteristics of the actual average ground for vertically polarized energy, *the radiated field strength is simultaneously decreasing in these lower lobes*. The net effect is that a simple horizontal dipole, mounted at the same total height, will radiate a stronger signal to the DX location than will an array of collinear vertical dipoles.

4. Let's take a look at two examples. First, assume a particular ham has a five-eighths wavelength high (about 40 feet) wooden mast for use on 20 meters. He can either run a five-eighths wave vertical wire up the side, or he can mount a horizontal dipole of aluminum tubing on top. The cost would be about the same in either case. Which will produce the better DX signal? Consideration of Figs. 2, 3 and 4 in the original article will lead to the conclusion that the vertical radiation angles from both antennas would be about 23 degrees. This is true, but the field strength from the horizontal dipole will be just about 3 db greater. These statements can be proven (with some effort) through use of Equations 27a and 27b, p. 699 reference 2, and the image concept. This was where the computer came in handy!!

5. Another example is a comparison between the antenna shown in Figs. 2d and 3, and a horizontal dipole mounted at one wavelength. Again the total heights are the same, and again the radiation angles will be about the same. But the horizontal dipole will give about 3 db more signal strength at this angle, and would give about 6 db were it not for the fact that the radiation pattern has split into two vertical lobes.

6. The purpose of my article was not to malign the vertical as a DX antenna. After all, many amateurs are having good success with them, and will continue to work their share of the DX. I would simply point out that the horizontal is consistently somewhat superior at frequencies above 10 megacycles, where equal total antenna heights are compared. On the 40 meter band the situation is about a toss-up, with possibly a very slight edge to the vertical, since a 40 meter horizontal dipole can't be supported on a single rickety wooden pole, but a vertical made of wire can be run up the side. For the man who is well-heeled, however, the horizontal will probably buy him better performance if he is willing to spend the money needed to gain the necessary height. On the 80 and 160 meter bands, I consider the vertical to be the best choice.

I hope the foregoing has shed some additional light on the DX antenna problem. For those who might be interested in discussing the problem further I am found frequently on the 40 through 10 meter bands (both SSB and CW), and would be happy to schedule a QSO with anyone to exchange views.

Bob Nelson K6ZGQ/5
San Antonio, Texas

P.S.—The DX antenna here is a tri-bander (20-15-10) at 72 feet.

Dear Wayne,

In response to the letter of Paul Gihring (W9JAB), in the March 73, I would like to correct what seems to be a misapprehension concerning the state of gravitational theory. While no contemporary physical theory is in totally satisfactory condition, it is not true that "any physical explanation or definition for the gravity field has scarcely been touched on." One might begin his reading on the subject with the basic papers of Einstein and others which were first published in the initial decades of this century. (Now available in Dover paperback). A considerable body of published experimental and theoretical materials exists in the literature from that time on until the present, where the work of Wheeler, Dicke and Feynman (to mention only a few) can be found continuing the same tradition in almost any recent volumes of the Physical Review. Unfortunately, the casual reader will have as much or more difficulty in reading these works as did the contemporaries of Maxwell in the last century, upon first encountering his momentous theory.

Still, I would hate to see this discourage the amateur experimenter. The fresh and unprejudiced point of view has nearly always proved fruitful for the progress of our knowledge of the physical universe, and this may be no exception. It may also be that the extreme care needed in observing effects known to be so small is not outside the realms of possibility for today's advanced hams.

Andrew J. Dufner WA7CXW/6
Los Gatos, Cal.

WTW

Dear Wayne and Gus:

I received the dope on WTW this morning and am glad to see someone come up with a sensible award for DXers. You can count on me trying to be one of the first WTWers from the fifth district. I used to be very active in DX back when Wayne was at CQ and Dick KV4AA was DX editor, but after the way CQ and ARRL has run their DX departments I just haven't had the enthusiasm I used to have back when I organized the West Gulf DX Club and was its president for the first two years.

Bob Wagner W5KUC
Honey Grove, Texas

Corrections to Articles

Dear 73:

I don't mean to nit-pic the feedline article by WØOPA in March because I enjoyed it very much, but in Fig. 3, I believe that Harvey meant for the antenna to be a folded dipole rather than a single dipole. For just a dipole, the balun should have been a 1:1 matching transformer or a bazooka.

David Clingerman WA3CCN

Dear 73:

Regarding the article on "diversity" in the April 73, page 92: Diversity recombination must be done after the detector, so that all RF phase info is lost. Otherwise there will be RF cancellation regardless of the number of antennas. There is a reason for the use of the two receivers and the author should have realized this.

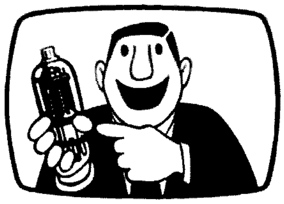
Tom Lamb K8ERV
Mansfield, Ohio

Dear 73:

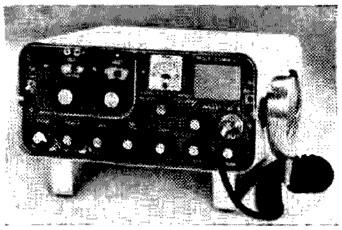
Fine article by John Nelson about Current Propagation.

Suggest that you run a warning in next issue cautioning against looking directly at the sun thru a telescope, binoculars or other device. Even with a smoked glass or other filter one could receive permanent damage to the eye. The best way is to reflect the image on to a white card where one may safely examine the sun's surface.

Hal Burnham K4WIQ
West Palm Beach, Florida

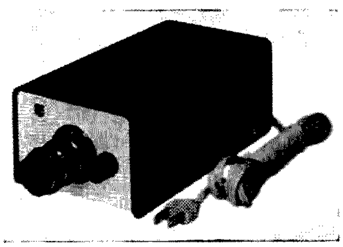


NEW PRODUCTS



Polytronics PC-6CD

You're all familiar with the excellent Poly-Comm PC-6. Now Polytronics is making a new model, the PC-6CD, that's civil defense approved in addition to all of the other features you know. The price is only $199.95 direct or from your dealer. Incidentally, Polytronics has recently been bought by Vitro Corporation of America, a large company well known to readers who are engineers or in the industry. We hear that they have some very interesting new products in the works. Polytronics, 900 Burlington Avenue, Silver Springs, Md. 20910.



S-S S-S TV Camera

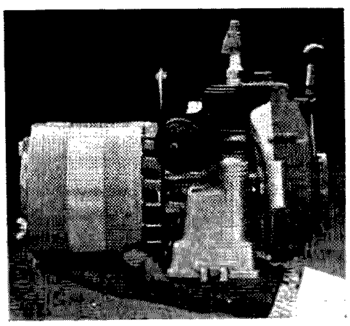
Squires-Sanders has just announced a new low cost, high quality solid state TV camera smaller than a telephone. The camera, the SS-310, delivers high resolution pictures on video monitors or conventional TV receivers, and may be linked to as many screens as desired. The camera contains 19 silicon transistors, 2 germanium transistors and 14 diodes. A noteworthy feature is its automatic light level control to insure clear pictures under virtually all conditions. Price of the SS-301, with f1.4 lens and 25 feet of cable, is only $289.95. Squires-Sanders also is making a large number of accessories available and the man to write for more information is Dick Marten at Squires-Sanders, Martinsville Road, Millington, N.J. 07946

ATV Research Transistor Camera Kit

ATV Research has put together an easy-to-build kit for an inexpensive transistorized TV camera. The kit with all parts including the pc board, but not the vidicon (which you can often get free) costs only $149.50. They also make the manual for the camera available for $5.00 (refundable with order) and hard-to-find components for the transistor camera or a tube-type camera can be bought for correspondingly reasonable prices. Send for their fascinating free catalog today. ATV Research, P.O. Box 396, S. Sioux City, Nebraska.

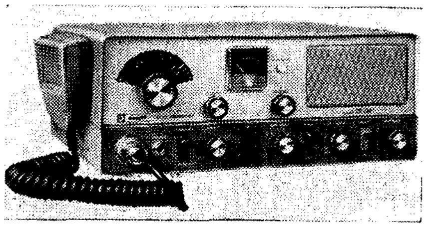
E-V 602F Mike

The new Electro-Voice 602F handheld dynamic mike is especially designed for mobile and other high noise applications with its noise cancelling features. The 602F has a positive, highly reliable detent switch and the whole mike is ruggedly built. Price is $57.50 from E-V distributors. You can get more information from Lynea Dalrymple (!) at Electro-Voice in Buchanan, Michigan 49107.



Tiny Tor

Bet you'd like one of these—and you can afford it, too. It's the Tiny Tor alternator that supplies up to 350 watts 115 volts AC, 6/12 volts DC—yet it weighs only 12 lbs., is only 7½ x 10¼ x 8½", is all-metal in construction, requires no batteries for starting and uses a high quality Ohlssen and Rice ¾ HP, 2 cycle recoil start engine. The price is a fantastic $79.50 and it's fully guaranteed: Algert Sales, 1805 Wilshire Blvd, Los Angeles, California 90057.



Knight-Kit 6 Meter Transceiver

The new Knight-Kit TR-106 6 meter transceiver is going to attract a lot of attention. It covers 50-52 MHz on receive with nuvistor rf stage for a .5 μv sensitivity, and 8 kHz bandwidth. The receiver is double conversion, so has high image and *if* rejection. The transmitter runs about 15 watts input to the final with high level plate and screen modulation. The TR-106 uses 8 MHz crystals or the Knight V-107 VFO. Both AC and transistor 12 volt DC power supplies are built in. Price for the transceiver kit is a low $139.95 and the VFO kit is $19.95. They're sold by Allied Radio, 100 N. Western Avenue, Chicago, Illinois 60680.

UHF Semiconductors from TI

Texas Instruments has recently introduced some new UHF and microwave semiconductors that look interesting. One is a Schottky-Barrier UHF mixer diode (TIV305) ideal for UHF tuners and microwave mixers. It has a typical noise figure of only 6 db at 900 MHz (mc) and a very low total capacitance to reduce the possibility of interference to other receivers. Local oscillator power requirements are very small, too. One of its big advantages is very rugged construction—it uses no delicate cat whiskers for contact. Price is $3.25 for one. Another new product is a microwave germanium planar transistor (TIXM103 and 104) that can replace TWT's, tunnel-diode amplifiers and paramps—economically. It's a good amplifier and offers up to 6.5 db gain at 3 GHz with a 5.5 noise figure. Typical NF at 1.5 GHz is 3.8 db. The price is $82.50 apiece for the 103 (takes three to replace a TWT), but compare that to typical TWT's at $2600. Also, they're much smaller, last longer and take much less power. Another TI semiconductor is the TIXS39, an NPN epitaxial planar silicon transistor ideal for transmitters. It features low IM distortion, f_T over 1 GHz, typical power gain of 13 db at 200 MHz and 3 watts dissipation. You can get more info from your TI distributor or TI Tech Service, P.O. Box 5012, Dallas, Texas 75222.

Alco Readout Indicators

Alco has just announced a new digital readout indicator that should appeal to many experimenters. It comes in two models, for 6 volts or 14, and includes the ten digits and a period. The indicator is only about 2½ x ¾ inches, so should fit just about anywhere. You can get more details from Alco Electronic Products, Lawrence, Massachusetts.

No-Mar Antenna Mount

Newtronics has just announced the new TGM-1 trunk groove antenna mount that permits you to mount your mobile whip without drilling any holes in your car's finish. The mounts don't interfere with trunk closing and are fully adjustable. Price is only $3.95 in chrome-plated steel or $4.95 in stainless. See your distributor for more information or write Jim Taylor W8EEC at Newtronics, 3455 Vega Avenue, Cleveland, Ohio 44113.

Drake SW-4

Serious SWL's should make sure that they get the complete specifications on the new Drake SW-4 international short wave broadcast receiver. It covers 6-6.5, 9.5-10, 11.5-12, 15-15.5, 17.5-18, 21.5-22, and 25.5-26 MHz with the crystals supplied and offers many of the features of the well-known Drake R-4A, though adapted specifically for SWBC listening. Price is $289.00 and you can get more information from R. L. Drake Company, 540 Richard St., Miamisburg, Ohio 45342.

Higher Power for TA-33 Jr.

Owners of Mosley TA-33 Junior Trap Master antennas may now have higher power by replacing the TA-33 Jr. radiator element with the MP-33 Tig-Array radiator element (MPK-3 Kit). Then the antenna will handle 750 watts AM/CW or 2000 watts PEP SSB. Write to Mosley, 4610 North Lindbergh Blvd., Bridgeton, Missouri 63042.

40 meters with your MP-33

You can use your new Mosley MP-33 Tig-Array on 40 by adding a 40 meter rotatable dipole (Kit TA-40KR) to it. Addition of the TA-40KR doesn't change any of the MP-33's electrical characteristics. The TA-40KR may also be added to 40 to the TA-31, TA-32, TA-33 and TA-36, or to the modified TA-33 Jr. (see paragraph above). Write Mosley for more information.

Vista 212 Tape Recorder

There are so many cheap junky tape recorders on the market these days that it is hard to know what to buy when you decide that you need something along this line. Most of us have probably been stung in our first buy, or at least have a friend who did.

While out in Los Angeles I dropped in at Radio Products Sales and they were featuring the Vista 212 for under $40. This, if it worked, looked like just what I needed. It could be used on the operating table to record DX contacts that I wanted to play back later . . . an accessory phone pickup was available so I could record phone calls I wanted to remember . . . and I could take it to club meetings and hear my talks over again to see where I might improve them. The little thing only weighed 4½ pounds, complete with batteries.

Naturally I bought one. I think the small size (8" x 10" x 3") made it particularly attractive for it was small enough for me to pack along on my trips. I also liked the two speed facility so I could record music, if I wanted, at the higher speed and most of the rest of my stuff at the slow speed which would give me an hour of recording on the 3½" reel of tape on each side. Another good feature was the automatic level for recording . . . there was no control for this, it just set the level automatically and I found that it would record voices across the room as well as my own right up close.

This little recorder goes everywhere with me now and I have not had a moment's regret about buying it. When I'm home it sits on my desk ready to record from the phone or off the air. When I'm away I pack it in a corner of my bag. I find the recorder to be quite reliable and simple to operate.

. . . W2NSD/1

Motorola Semiconductor Data Supplement

A few months ago we mentioned the new Motorola Semiconductor Data Manual, a fat, full listing of all the Motorola Semiconductor devices with their complete spec sheets and some other useful information. Well, Motorola hasn't been sitting on their hands, as the new Supplement 1 to this manual proves. It costs $1 and lists all of their newer semiconductors. You can get a copy from your Motorola distributor or from TIC, Motorola. Box 955, Phoenix, Arizona 85001.

Propagation Chart

JUNE 1966

J. H. Nelson

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	14	7#	7	7	7	14	14	14	14	14
ARGENTINA	14*	14	14	14	7	7	14	14	21	21	21*	21
AUSTRALIA	14	14	14	7*	7	7	7*	7	7	7#	14	14
CANAL ZONE	21	14	14	14	7	7	14	14	14	21	21	21
ENGLAND	14	7	7	7	7	7	14	14	14	14	14	14
HAWAII	14	14	14	14	7#	7	7	7#	14	14	14	14
INDIA	14	14	7#	7#	7#	7*	14	14	14	14	14	14
JAPAN	14	14	7#	7#	7	7	7	14	14	14#	14#	14
MEXICO	14	14	14	7	7	7	14	14	14	14	14	14
PHILIPPINES	14	14	7#	7#	7#	7	7	7*	14	14	14#	14
PUERTO RICO	14	14	7*	7	7	7	14	14	14	14	14	14
SOUTH AFRICA	7#	7	7	7#	7#	14	14	14	14	14	14	7#
U. S. S. R.	14	7*	7	7	7	7*	14	14	14	14	14	14
WEST COAST	14	14	14	14	7	7	7*	14	14	14	14	14

CENTRAL UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	14	14	7#	7	7	14	14	14	14	14
ARGENTINA	21	14	14	14	7	7	14	14	14*	21	21*	21
AUSTRALIA	14	14	14	14	7*	7*	7	7*	7	7#	14	14
CANAL ZONE	21	14	14	14	14*	7	14	14	14	14*	21	21
ENGLAND	14	7	7	7	7	7	14	14	14	14	14	14
HAWAII	14	14	14	14	7*	7	7	7#	14	14	14	14
INDIA	14	14	7#	7#	7#	7#	7*	14	14	14	14	14
JAPAN	14	14	14	7*	7	7	7	14	14	14	14#	14#
MEXICO	14	14	7	7	7	7	7	7	14	14	14	14
PHILIPPINES	14	14	14	7#	7#	7#	7	7	7*	14	14#	14
PUERTO RICO	14	14	14	14	7	7	14	14	14	14	14	14
SOUTH AFRICA	7#	7	7	7#	7#	14	14	14	14	14	14	7#
U. S. S. R.	7*	7*	7	7	7	7	14	14	14	14	14	14

WESTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	14	14	7	7	7	7	7	14	14	14
ARGENTINA	21	21	14	14	7	7	7	14	14	21	21*	21*
AUSTRALIA	21	21	21	14	14	14	14	7	7	7#	14	21
CANAL ZONE	21	21	14	14	14	7	7	14	14	21	21	21
ENGLAND	14	7#	7	7	7	7	7	7*	14	14	14	14
HAWAII	14	21	21	14	14	14	14	7	14	14	14	14
INDIA	14	14	14	14	7#	7#	7#	7*	14	14	14	14
JAPAN	14	14	14	14	14	7	7	7	14	14	14	14
MEXICO	14	14	14	7	7	7	7	7	14	14	14	14
PHILIPPINES	14	14	14	14	14	7#	7	7	14	14	14#	14
PUERTO RICO	14	14*	14	14	14	7	14	14	14	14	14	14
SOUTH AFRICA	7#	7#	7	7#	7#	7#	7#	14	14	14	14	7#
U. S. S. R.	14	14	14	14	7	7	7#	14	14	14	14	14
EAST COAST	14	14	14	14	7	7	7*	14	14	14	14	14

Very difficult circuit this hour.
* Next higher frequency may be useful this hour.

Good: 1-4, 6-8, 10-13, 17-20, 22, 23, 25-28
Fair: 5, 9, 14, 24, 29, 30
Poor: 15, 16, 21
VHF DX: 3, 8, 9, 16-18, 29, 30

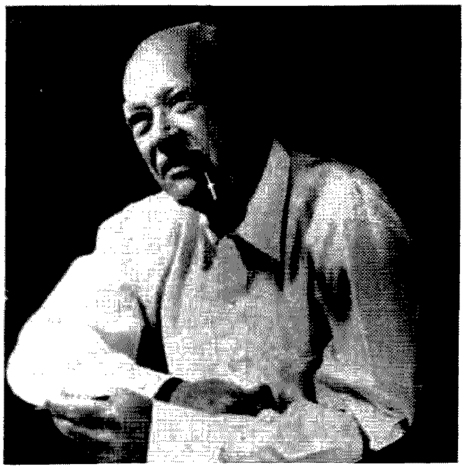
Howard Pyle W7OE
3434—74th Ave., S.E.
Mercer Island, Wash. 98040

Boy! Do You Want a Law Suit?

Have you got five, ten, maybe fifty thousand bucks salted away? (Who has?!). Bet if you have you'd like to keep it! Most of us would so why hang it on a convenient tree limb for anybody to shoot at?

Do you know that you are doing just that if you have a guy wire from an antenna mast or rotary beam support tied to a stake in the ground or an equivalent anchor? Maybe even one or more guys for your TV mast fall in this category as well. Sure they're 'inconspicuous' . . . you planned 'em that way so that they wouldn't be a neighborhood eyesore but you'd better do something about the first six feet or so above the ground anchor. Just let a man or woman, boy or girl trip over an unseen guy wire, particularly in the dark, and maybe break a leg, an arm or a basketful of ribs and you're in trouble! They can sue you for pretty heavy loot you know, and maybe they will! You can perhaps sue them back for possible trespass on your property but you'll have a pretty weak case; *you* didn't suffer any physical injury. At any rate it can cost you in addition to a heavy award to the plaintiff by a judge probably sympathetic to the latter, rather substantial attorneys' fees to keep such award as far down as you can. Probably you'll also be faced with rather heavy costs to the lawyer who prosecutes your trespass case if you seek to file such suit.

Why not play it safe and avoid such possibilities? Most of us hams who rely on a mast or tower to support our beam or 'sky-wire', as the case may be, have one or more guy wire anchors placed in what are really pretty precarious spots about the yard or garden. These are very definite hazards to those who are not "in the know." You can protect yourself against causing such a hazard by following the example of the utility companies; power and telephone mainly. Ever notice that wherever they find it necessary to locate a guy wire anchor at ground level or thereabouts, they invariably mark the lower six feet or so of guy wire in a prominent manner. The major companies generally use a semi-circular galvanized iron shield, commercially available to them through their pole line supply companies and fitted over the lower end of the guy



wire, clamped in place by "U" bolts or similar means. The more modest installations of the smaller companies often use a simple 1"x4" board about five or six feet long, also secured to the lower end of the guy wire with "U" bolts or similar and generally painted with aluminum or gloss white enamel. Either of these methods is good and it gets them out of the "court-room woods." In other words, ". . . if you can't see it and as a consequence fall over it, 'taint our fault; we marked it plainly!"

You can even beat that and generally at no cost or, at most, a few pennies. Before you tie your ground wire(s) into the ground anchor, slip a piece of half or three-quarter inch pipe over the wire so that its butt rests against the anchor. If you don't have such a piece of scrap pipe you can pick up a suitable length of iron or aluminum tubing from your local hardware or building supply dealer for a nominal sum. If pennies really count, use a five or six foot length of rubber or plastic garden hose. Whatever you use though, paint it with shiny aluminum or gloss white enamel . . . something which will make it discernible even on a dark night. If you're a stickler for 'perfection' you can even stripe it like a barber pole using a fluorescent reflecting enamel. Regardless of what you do to solve this problem, you have shown good faith in warning the general public that there is an obstruction . . . take care! It's liable to save you all of your bonds and your savings account in the long run!

. . . W7OE

YB of W7OE is well-known to 73 readers. His early calls (he's 68) were MA, HP before 1912 radio laws), 7HP . . . 7OE, etc. YB is a retired electronics engineer with the U. S. Government and has written several thousand articles and nine published books since he was first published in Gernsbacks' Modern Electrics in 1912. YB is strictly a CW man and has never had phone equipment.

Don Hansen W9ZZH
2143 North 70th Street
Wauwatosa, Wisconsin 53213

Ohmmeters

Ohmmeters, devices for rapidly measuring dc resistance, are simple instruments. Of the many types, series and shunt ohmmeters using d'Arsonval movements will be discussed.

The basic circuit for a series ohmmeter is shown in **Fig. 1.** A linear d'Arsonval movement in series with a battery and external resistance comprise the basic series ohmmeter. The meter has series resistance R_M and the battery has series resistance R_B and voltage rise E. A resistor of unknown value is connected across the terminals of the ohmmeter and completes the circuit. The deflection of the meter is a function of the resistance of R_x. If the circuit components are fixed, the meter can be calibrated directly in ohms. The values of E, R_B, R_M, and R are selected so the meter indicates full scale with the input of the meter shorted ($R_x = 0$). With the input of the meter open (R_x approaches infinity) the circuit current is zero. As a result, the series ohmmeter has a non-uniform scale with zero resistance at the right and infinite resistance at the left.

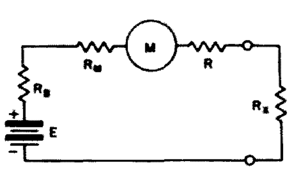


Fig. 1.

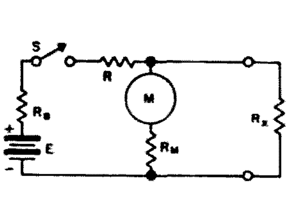


Fig. 2.

The sum of the resistances R_B, R_M, and R is the internal resistance of the ohmmeter. The sum can be represented as R_S. If a value of R_x is selected so its resistance is equal to the resistance of R_S, the meter will indicate midscale. The internal resistance of any series ohmmeter is equal to the midscale value marked on the scale.

The basic circuit for a shunt ohmmeter is shown in **Fig. 2.** The shunt ohmmeter derives its name because the unknown resistance R_x is placed in shunt with the meter. A complete circuit exists, even with R_x disconnected. Therefore, switch S is provided to eliminate battery drain when the instrument is not in use. The values of E, R_B, R, and R_M are selected so the meter indicates full scale when R_x is disconnected (R_x approaches infinity). When R_x is equal to zero, the meter current is zero because the meter movement is shunted by a short circuit. As a result, the shunt ohmmeter scale is the reverse of the series ohmmeter. Like the series ohmmeter, the shunt ohmmeter scale is also non-uniform.

The equivalent internal resistance R_P of the shunt ohmmeter is

$$R_M+R+R_B$$
$$R_P = R_M(R+R_B)$$

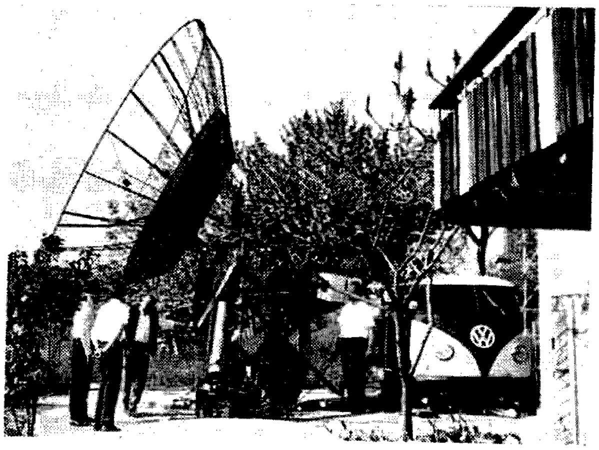
If a value of R_x is selected so its resistance is equal to the resistance of R_P, the meter will indicate midscale. The internal resistance of any shunt ohmmeter is equal to the midscale value marked on the scale.

As the battery in either the series or shunt ohmmeter ages, its internal emf (E) and series resistance (R_B) change. The series and shunt ohmmeters to be practical, must have an adjustment to be made before the instrument is used and to compensate for battery aging. Resistor R is made variable to accomplish these adjustments.

When the battery emf and resistance change, R can be adjusted to partially compensate for the change. Since the adjustment affects only the internal resistance and not the emf, the meter calibration still becomes in error as the battery ages. Most commercial ohmmeters have been designed to limit the amount R can be changed to hold the error to a reasonable value.

Ohmmeters are among the simplest and easiest to use devices for measuring resistance. Most commercial ohmmeters are made as part of multimeters or VTVM's. Every shack should have an ohmmeter as part of its repertoire of test equipment.

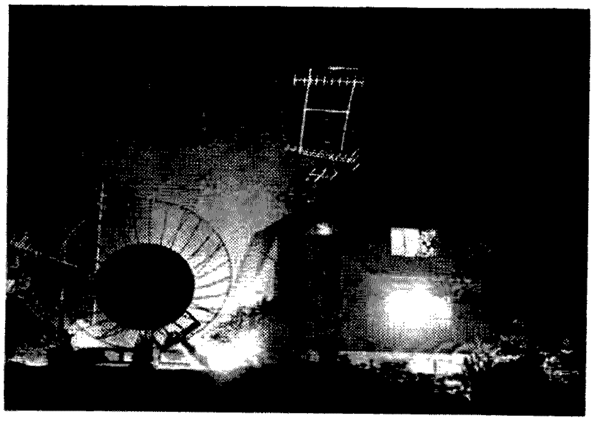
. . . W9ZZH



(*Continued from page 2*)

The next morning I drove down to Stuttgart and spent the day walking around that beautiful city and taking pictures. That night I had dinner with DJ1BZ, DL4SS and DL4SZ at the famous television tower restaurant which stands high on a mountain overlooking the city. When we left we found a QSL from HB9PL stuck on DL4SS's windshield indicating that Peter had been there to visit the observation platform above the restaurant. He of course had no way to know that I was there.

Ed, DL9GU, who had talked with me at the Frankfort dinner, had phoned ahead to HB9RG and the group was waiting for me when I arrived at Zurich. I left my car to have its 300 mile oil change and Hans drove me to HB9RF's house up in the mountains. DJ3EN Kurt had come down from Germany with Al W7AUR/DL4 for the gathering and the five of us sat around all afternoon talking and taking pictures. Is seemed very remarkable to me to find this little group of amateurs way up in the Swiss Alps with their dish antenna and old VW bus full of gear they had built. Even more remarkable are the contacts they have made with it on 432 mc and 1296 mc across the Atlantic ocean. How small our world is to amateur radio. Here I was sitting talking with these fellows about Sam and all the others that I know who are interesting in moonbouncing. It was exactly the same as talking with the gang down in Massachusetts or in Arecibo. A couple of months later I was on the Arecibo end of a moonbounce 432 contact with this same group.



Later Hans, Al, Kurt and I drove on to the HB9RG home, high on another mountain, working HB9RF all the way with a Gonset two meter Sidewinder. After a delicious dinner we contacted stations as far as Hannover, some 600 miles north. Around midnight Kurt and Al headed back for Germany and I slept over in the spare room. Ham radio has warm friendships wherever I go in this world.

DX alarm

Now I don't know about you, but I would find it handy if there was some frequency that I could check into now and then to find out if there is any rare DX around the twenty meter band. My usual practice is to turn on the receiver and tune carefully up from 14200 listening for any pileups. This doesn't always work for pileups are often quiet while the DX station is transmitting, though, unfortunately not always, and it is not difficult to tune right over one of the rarest stations and not even know that I've missed him.

What I propose is this . . . see if you like the idea. The next time I scout a rare one I'll zip on down to 14273 when I'm through and make a general announcement for anyone listening. If enough of us follow this procedure I think we'll find that a lot of fellows will just leave their receiver tuned to that channel waiting for an alarm. Also, when first coming on the band we might use this channel as a check in to see what has been going on. If you keep your remote VFO on this channel when you're not using it to work the low end you can just switch automatically on there and sound off.

What do you think? All those in favor see me on 14273. All those opposed write in and complain. All others forget I mentioned it.

W2NSD/1 schedule

For a year now I've been intending to set up some sort of schedule frequency and time so those of you with questions about anything can ask them in person. Anything except business matters, of course. If you have any questions about your subscription please write a postcard, don't call me on the air.

The problem is that first of all I am wretchedly forgetful and have a long history of miss-

ing schedules by about 40 minutes or so. I remember them up until a half hour before sked time, then next time it crosses my mind is an hour or so later...and in some cases a week later, very embarassing.

With this limitation in mind, I'll set up tentative schedules to be on 14273 at 0000 GMT. You'll find me around 14230 or so in the mornings frequently at 1200Z and often afternoons around 2000Z. At these times I'm usually looking for DX and would prefer to be called only if something is really important.

I'll be away during May, but should be around a bit during June and July. August and September I'll be away again.

"I don't agree with everything you say . . ."

On the air . . . at conventions and at club meetings I am often met with this phrase. My jovial answer is that I should certainly hope they wouldn't agree with everything. My private opinion is that either they have not read my editorial very closely or else I have failed to get across my idea.

Many fellows say they want facts to back up what I say. This is possible in some cases, but in others this comes hard. For instance, when I point out to you the league is floundering around with no definite plans for the preservation of our hobby I am giving you an assessment that is difficult to document.

You can, if you are interested, check into anything I say for yourself. I know of no one who has taken this interest who has found my evaluation in error or even distorted. For instance, to find out where the League stands on providing leadership through the International Amateur Radio Union all you have to do is talk with the heads of a half dozen national radio societies in Europe and a few of the top boys in the Americas. If this is too much trouble, then read the RSGB Bulletin, the REF Bulletin, DARC and others. The ARRL stands condemned.

Before anyone goes accusing me of lying or distortions I think they should spend the 10¢ postage for a copy of the Huntoon letter to the National Convention Committee in which he enumerates 28 instances where he claims I have lied or distorted facts in my editorials. This is our official record of the claims against my editorials by the one person who should best know where I have made any mistakes about the ARRL.

The Huntoon letter is one of the biggest mistakes that John has ever made. In my answer to his letter I take each of the 28 complaints about my editorials and show how he has distorted his criticism, or lied. As an example of the Huntoon letter, he writes that I show "complete ignorance of League structure and affairs." To back this up he writes, "He (me) states, 'The primary activity of the ARRL is to publish QST, the Handbook and other assorted publications.' In fact, the purposes of the League are spelled out in its Articles of Association, where publication activity is mentioned only as the last one of 8 major ob-

AMERICAN RADIO RELAY LEAGUE
INCORPORATED
Administration Headquarters
NEWINGTON 11, CONNECTICUT, U. S. A.

Dear Fellow Amateur:

I'm sure that, in recent months, you have missed the monthly arrival of QST, packed with the latest news of amateur doings, technical developments, construction articles, regulatory information, specialized columns, station activities and operating news.

But ARRL is more than QST magazine. Your League coordinates organized operating activities - contests, awards, code practice, self-policing, traffic and emergency networks, civil defense communications - to write a continuing record of amateur performance in the public interest, convenience and necessity. Your League provides a myriad of services for individual members and affiliated clubs - technical information, TVI help, a library of films on loan without charge, licensing advice, a planned public relations program, guidance in legal difficulties such as zoning ordinance problems, etc. Your League serves as headquarters of the International Amateur Radio Union, coordinating activities of some 50 national amateur radio societies around the world.

Just in the last few years, some of the accomplishments of the League in behalf of amateur radio are:

1) A commemorative postage stamp honoring hams.

2) Expanded privileges on the old 160-meter band.

3) A successful bill for reciprocal operating privileges, through interesting Senator Goldwater in its sponsorship, and League appearance at several Congressional hearings to secure adoption.

4) An expanded program, the Amateur Radio Public Service Corps, to help justify our use of valuable radio frequencies.

5) A new headquarters administration building, fitting the stature of the national amateur organization.

6) A larger and (we think you will agree) better QST.

7) A new "junior" Handbook - "Understanding Amateur Radio."

8) Relaxation of RTTY dual identification requirements.

9) Removal of power restrictions in the 420-Mc. band.

10) Participation in the new "Inter-American Union of Radio Amateurs" to strengthen amateur ties in this hemisphere.

Your renewed membership in the League will help support projects like these and more to come.

Perhaps most important, the League is the representative of the amateur in national and international regulatory fields. This work is vital to our existence, and particularly so with the world in its current turmoil. Even if you are currently inactive, chances are you have plans to get back on the air at some future time. Your membership in the League, with that of others who may be inactive, will help insure that the amateur bands will continue to be available. The more support the League has, the more effective we will be. We would like to have you back on the membership roster again, and send QST to you each month. What say? 73,

Sincerely yours,

John Huntoon, W1LVQ
General Manager

jectives dealing with the enhancement of and representation for amateur radio."

Please not the sly change there. I said "primary activity" and Huntoon answered "purpose." Now, from what Huntoon says I think you can see that something has gone all wrong with the purposes of the League for there certainly is no question whatever about publishing being their primary activity. This is one of the simplest facts to substantiate you could ask for. A copy of the ARRL financial statement is available at no charge to all ARRL members for the asking. If you take a few minutes to sort out this maze of figures you will begin to see what is going on. Just total up the expenditures that reasonably seem to be publishing expenses. Then total up those that look like expenses for league services other than publishing. This works out to be about 90% for publishing and about 10% for non-publishing.

Taking the last available financial statement in hand you will find that the Board of Directors was responsible for a mere 2.7% of the total expenditures of the League. I'll leave it to you as to whether John is guilty of trying to confuse the issues here by changing the subject to "purpose" instead of activity.

Did I pick an isolated example to answer here? Not at all. Every one of his answers are just as devious and distorted.

You should know that Huntoon has flatly refused to face me in front of any club and that the only time in history that he did face me he read from a prepared text and refused to answer any of my questions. I stand ready to face him and answer his questions if he will answer mine. This is a challenge that I have made before and which he dares not accept.

If you find that Huntoon or any of the ARRL Directors are going to speak to your club I suggest you send for a copy of the reprint of Huntoon's letter and my answer so you can ask intelligent questions of your speaker. Do not be surprised if they answer by getting mad and stalking out . . . this has been their only reply so far. It is up to you to make the League officials face the mess they have created and let them know that they can't go on fooling everyone with pontificial prepared speeches and pious generalities. It is up to you to pin them down. Demand to know why the League does not have a lobby in Washington and don't accept any evasions about the League counsel down there supposedly "representing" you. He represents the League before the FCC and cannot legally approach a Representative or Senator with regard to any Congressional legislation. Demand that Directors' meetings be fully reported and that the secret pre-board meetings be stopped. Demand that full information about salaries for top paid employees be made public and full information about the incredible retirement pay be revealed. Members certainly have a right to know where their money is going. Demand that the yearly financial statements be published in QST along with detailed explanations of major expenditures.

Wayne Green blowing hot air again you say? OK, those of you who have dropped out of the League recently have received a letter signed by John Huntoon listing ten accomplishments of the League in behalf of amateur radio in the last few years. This letter is the most incriminating of all. It is a blatant admission of the almost complete lack of value of the League to amateur radio. What does Huntoon list as the first and foremost accomplishment of the League in the last few years? #1. A commemorative postage stamp honoring hams. This is indeed a true memorial to the League: The Purple Botch. Remember that this was voted by stamp collectors as one of the worst stamps of the year and few hams will argue the point.

Perhaps Huntoon is being modest for the League and the other nine accomplishments are more noteworthy? #2. is expanded privileges on 160 meters. This is nice . . . it is a great accomplishment. How many of us has it benefited? Maybe a hundred? OK, maybe two hundred at the outside. That is a pretty poor showing for the number two accomplishment of the League in recent years. #3 is the reciprocal licensing bill. Whoa, fellows. Sure, you pushed it, finally, but you held it up for several years when others were trying hard to get support for it. After several years you finally stopped fighting it. This is like Russia taking credit for the defeat of Japan in WWII. #4 is the Amateur Radio Public Service Corps. Let me ask a foolish question . . . how many of you have any idea what the ARPSC

is? #5 is the new headquarters building. This is an accomplishment of the League in behalf of amateur radio? #6 is a larger and better QST. I don't know how it is better, but if you'll check the size you'll find it has skinned down by about 16 pages over the last two years. #7 accomplishment is the publication of "Understanding Amateur Radio." #8 is nice, the relaxation of RTTY dual identification requirements. Several hundred hams benefit from this major step ahead. #9 is power restriction removal on 420 mc. A dozen hams benefitted, maybe three dozen. #10 is reaching way into the bag . . . participation in the IARA.

I am sure that all of us are justifiably proud of that list of accomplishments.

Don't forget to send that large self-addressed envelope with 10¢ in stamps for the Huntoon letter and my answer. Find out where the lies are coming from once and for all.

SSB Contest

Though I'm as an inveterate rag chewer as anyone . . . ask XW8AX about the longest QSO he's ever had (over an hour) . . . there is something fascinating about contests. During the 24 hours of this contest I managed to work 492 stations in 90 countries (206 prefixes). Not bad for a poor-man type ham station with just a little old kilowatt and a tiny three element beam up against the big guns with up to ten kw and six over six beams, etc. Last year only Don Miller operating K2HLB (a very very big big gun) did better in the U.S.

Looks like Don won again this year . . . for the whole world. Perhaps he got piqued at the tremendous advantage DX stations have in this contest. At any rate he sat it out on a small lump in the Pacific called Minerva Reef using the home brew call of 1M4A. The last I heard he had almost 2000 contacts and lacked only 1M4 for working all prefixes. I played it cool and let him work 1200 more eager stations before trying to break through the QRM and thus got him right off when I tried.

Outside of Don there wasn't much rare DX around in the contest. EA8AH came on for a couple minutes, heard the explosion and "went to dinner." I think this same thing happened to most of the others. They are gun shy now and find other things to do on contest weekends. It was a field day for any G, D, SM, etc., that wanted to fill a few shoe boxes with U.S. QSL cards. I'm not sure I understand the fascination of this . . . and, as I said before, I don't know why I enjoy the whole procedure.

No July hamfest this year

Our hamfest was a lot of fun last year and we thought we might make an annual affair out of it, but I'm going to be away from here too much to really put on a good show so we have decided to put it off this year and see if we are in better shape next year.

During May I will be visiting Stockholm, Helsinki and Oslo. Late in the month I'll be out at Anaheim for the convention. In June and July I'll be getting ready for the safari in Africa. This means shots for everything imaginable, visits to consulates for all of the countries we will visit for visas and, if possible, ham licenses, shipping stuff over we'll be needing, plenty of target practice with my new Weatherby 300 Magnum gun, etc. I sure wish you were all coming . . . what a trip we'd have!

Paul will be away part of the time too. He's going over to see Europe in June. He's doing a fine job of editing 73 and certainly rates the vacation.

WTW vs DXCC

Both Gus and I realize what we are undertaking with the establishment of the 73 Worked The World award. Rather than mount a ten year to get the League to make the changes in their DXCC award which would better meet the present day needs of amateur radio, we have decided to go ahead and make the award available under our own steam.

We know that a large part of the activity in amateur radio is a product of the DXCC award. The award is almost completely responsible for all of the DXpeditions we have been seeing so frequently of late. It is mostly responsible for the mountain of QRM that makes life miserable for operators in rare countries.

But when you have something as integral to amateur radio as this award you have a mandate to keep it up with the times and not let it get thirty years out of date. I believe that the basic drawbacks of DXCC which we have overcome with WTW will eventually swing amateur radio into acceptance of this more up to date award.

First and foremost CW ops want to count their CW countries and phone ops want to count their phone countries and never the twain shall meet. WTW issues separate certificates for phone and CW and keeps a complete set of records for the two modes. The two will be listed separately in 73.

Secondly, each amateur band is a separate identity and it is like mixing apples and eggs to count 160 meter countries with the same credit as 20 meter countries. WTW issues separate certificates for each amateur band. This means that 75 meter ops are in competition with 75 meter ops and 10 meter ops with 10 meter ops in the country race. These will be listed separately in 73.

Thirdly, how can a newcomer even hope to get a high place on the QST honor roll? It is solidly topped by old timers who got many of the hard ones years ago. WTW requires that you work a country at least once every five years to continue to keep credit for it. This means that an enterprising newcomer can make his way well up into the country totals at any time. It also means that the old timers are going to have to keep plugging in there to hold their place.

Then there is the sticky question of what is and what is not a country. The League list is a mass of contradictions of any set of rules you care to state and has led to a good deal of hard feelings. Our solution to this is to accept all of the ARRL designated countries, plus those of recognized amateur radio societies around the world. The French society certainly should be an expert of what French possessions count as countries, etc. If some spot is so obviously not a country that no national society will recognize it as such, then it just won't count.

As the advantages of WTW over DXCC become better known I expect that it will become more popular. In the meanwhile both Gus and I will appreciate it lf you will talk up WTW on the air. If you have any questions about the award please drop Gus a line via 73, Peterborough, N. H. 03458.

Another ARRL blunder? At least.

The word has been going around that the League may change its mind about giving credit for Ebon Atoll and Cormoran Reef. Chuck Swain was sailing around the Pacific Ocean putting rare "countries" on the air to give fellows DXCC credits and he checked with the League before going to Ebon to make sure that it would count for DXCC before making the dangerous journey. Chuck was lost at sea along with Ted ZL2AWJ a few weeks later on their way to activate another ARRL DXCC country. If the League now decides to discount Ebon I think they deserve a scroll for the outstanding bad sportsmanship of the year. . . . Wayne

Caveat Emptor?

★ **Price—$2 per 25 words for non-commercial ads; $5 per 25 words for business ventures. No display ads or agency discount. Include your check with order.**

★ **Type copy. Phrase and punctuate exactly as you wish it to appear. No all-capital ads.**

★ **We will be the judge of suiability of ads. Our responsibility for errors extends only to printing a correct ad in a later issue.**

★ **For $1 extra we can maintain a reply box for you.**

★ **We cannot check into each advertiser, so Caveat Emptor . . .**

CLEGG 22'ER, Johnson VFO, excellent $190, Hammarlund HQ 180 AC New $295, Johnson Matchbox and SWR Bridge 1KW PEP #250-23-3 New $70. All in factory packing. WA2LIM 212-461-1779 or 146-31 60th Avenue. Flushing, New York 11355.

LIKE NEW: Viking 2 and 122 vfo, $90; Mosley CM-1 receiver, speaker, Q multiplier, $100; HA-1 keyer, Vibroflex paddle, $70; Two8er, many excellent modifications, crystals, vfo, mobile supply, $65. Sorry, no shipping. Alan, WA6MOW tel. 213 447-4469.

COLLECTORS ITEM—all volumes Rider Troubleshooters Manuals: Schematics for hundreds of old radios beginning 1900 on: Western, Atwater-Kent, United, Detrola, International, etc. $44.00. Motorola 6 FM (52.525) Coffin Box transmitter/receiver. Perfect, 12 vdc/110 vac ps $70.00. VOX new printed circuit board with all capacitors, sockets, resistors, $11.00 All FOB, Richard M. Jacobs, WAØAIY, 1015 Glenside Place, University City, Missouri 63130.

IMMACULATE! Drake R-4 receiver, Ms-4 speaker $300.00. Drake T-4X XMTR, AC-3 Power supply $360.00. Norris, WØJKV, 1623 Steele Street. Denver, Colorado 80206. 303-388-6977.

WANTED: For Antique Tube Collection: Arcturus Blues, Western Electric, Hytron, Machlett, Zahl Tubes, and Incandescent lamps of 1900 era. Vern Thompson W9JWW, 1403 South Fourth Street, Ettingham, Illinois.

EXCELLENT CONDITION: Hallicrafters SX-101-III $150. Eico 720 $50. 722 $35. John Andrews K1VHO, 290 Brigham Hill Road, Grafton, Mass. 8392630

ELMAC PMR-6A RECEIVER with AC power supply, in excellent condition, best offer. J. McKee, 52-30 39th Avenue, Woodside, N.Y. OL 1-1610.

UTICA 6-METER Transceiver with CW, like new. Heath SB300, accessories, excellent. WA1BTE, Paul R. Letourneau, 1 Letourneau Street, Rochester, New Hampshire.

GALAXY III, matching speaker, Heath Mobile supply, etc. $265. Perfect. Take F. W. Ranger 2 in trade. J. O. Aber, Canisteo, New York 14823.

NATIONAL 6N2 converter, six and two meter input, 14-18 mc output, factory-wired, built-in power supply $30. Allan Weaver, K1IPT, Box 5214, McGuire AFB, New Jersey 08641.

TAPETONE TWO METER 417A converter like new, 30-35 mc output $35. Hallicrafters S-38 E $20. Allan Weaver, K1IPT, Box 5214, McGuire AFB, New Jersey, 08641

NEW COAXIAL RELAYS 12vdc coil, 150 watts up to 470 mc, no connectors, secured coax leads; antenna-2" RG58, xmitter-12" RG58, receiver-8" RG188 $2.00 postpaid USA Sid Emmons K8ZES, 660 Willowcrest, Galion, Ohio 44833.

WANTED BRITISH EL 37 DX transmitter reasonable, Box 185, Myrtle Beach, S.C.

VW OWNERS 6 volt transistorized power supply, Heathkit HW 32, 20 Mtr. 200 W. PEP SSB Transceiver, Hustler 20 mtr. antenna, PTT mike and speaker. No changes to car wiring necessary. First cert. check for $175.00. takes all or make offer. D. Crosby, 147 Charter Circle, Ossining, New York. 914 Rogers 2-1638.

DX-100 140 watts owt cw 125 phone. HQ180 c rcvr matching speaker switching relay and #1 gain tri-bander antenna $450.00. Larry Parlin, K1RWN, Box 181, Franklin, Mass. 02038.

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RME 4300 and 4301 $100.00, HE-45B and HE-61 vfo $100.00, Ameco CB-6 converter 28mc. IF $15.00, Home brew 6 mtr transmitter, 15 watts, power, supply, ant. relay $30.00. Knight vfo $14.00, 2-BDT trap ant. $10.00. All working. First $235.00 takes all. FOB. D. L. Canady K9OPL, Box 324, Westville, Indiana 46391.

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73

JULY 1966

60¢—How About That?

Amateur Radio

3 Magazine

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never say die

Amateur radio convention?

Have you ever considered the possibility that we amateurs could be self-governing? Suppose, for example, that a yearly national convention was held for the review of our hobby and that the actions of the delegates to the convention were held binding on us all. Clubs around the country could send a delegate to represent their interests. This would encourage club activities and would get most active amateurs to join clubs in order to have a say in their rules.

The convention might run similarly to the international conferences with committees being established to sort out the ideas and present the result of their study to the convention for vote.

We might have a committee to study contests and recommend changes in rules or even the elimination of no longer needed contests. They might also suggest needed contests. Obviously the members of the committee would be those interested in contests. The certificate hunters could have their committee and on a yearly basis hash out their problems and keep up to date. Ditto the DXers, RTTYers, traffic nets, and every other phase of amateur radio.

Maybe every other year would be enough. It sounds like a lot of work. I do think it would get a lot more fellows interested in the running of amateur radio and that the end result would be much faster progress.

If we were to set up such a convention or conference system of changing our rules I am quite sure that we would find the FCC quite willing to go along with it. We know darned well that the FCC doesn't like the present rule making system. If we give them a reasonable alternate I think they would buy it.

Intruders

One of the difficult and growing problems in amateur radio is the intruder. This takes the shape of mysterious RTTY signals running endlessly, obviously commercial CW signals or just plain short wave broadcasting. While we are reasonably sure that such signals in our 20 meter band are illegal, we are never sure of those down on 40 or 80 meters and w hesitate to make an issue of their activit when we are not sure of our own grounc We know that the ITU agreements do includ some sort of sharing arrangement for thos lower bands so we are cautious.

The lack of agressive retaliation to this ir trusion has encouraged stations in countrie who take their ITU commitments lightly (c who are uncommitted at all) to step in and us our bands wherever we permit the QRM leve to accommodate them. Perhaps I might d gress for just a bit at this point to throw pointed barb at the champions of QRP. agree with them that it is indeed delightfi to work 100 countries using 100 watts powe and if they find this entertaining I agree the they should continue to do what is fun fc them. But I think that they should not fee at all pious about this little hobby of thei and try to shame others into following the example for it is the high power stations the are holding our frequencies for us, not th QRPers. As soon as the QRM level drops th commercials move in. Though I do not advc cate the use of higher than legal powers b operators, I do think that we would hav little to lose and much to gain if the worlc wide power level were set at one kilowat Thirty years ago this was a bit hard to ger erate, but today it is hardly out of reach any average amateur.

What can we do about the intruders? Firs of all we can organize ourselves and deter mine to keep our ham bands for hams. W know of several methods of ridding ourselve of unwanted signals and I am sure that a littl thought and asking around will turn up som more practical approaches to the problem. certainly would be interested in publishin any information available on the subject an will do all I can to help coordinate any effor that organize.

The number one approach, of course, is t find out as much about the intruding signa as possible and report them to our own gov

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Editor's Ramblings

Helping out

One thing hams have always been famous for is helpfulness. Hams have helped out in emergencies, for public events, for servicemen's phone patches and in many other ways. They also used to help out young hams and others interested in amateur radio. In fact, at one time, most hams got their knowledge of electronics and amateur radio from older hams who were glad to help out. But things have changed a lot now. You can be licensed even without talking to a ham. Needless to say, hams who get on the air this way tend to be ignorant of old ham traditions, whether the traditions be good or bad. They're often impolite on the air and operate their equipment improperly, causing interference to other hams or to other services. Why? Because they don't know any better. They can memorize the license manual and study books and listen to code records, but that can't teach the things an older ham can. The example, teaching and friendliness of other knowledgeable hams can do far more to improve the competence and attitude of hams than having to take a government test can.

So what can be done to try to help young hams? The best way is probably through strong local radio clubs. A good club with plenty of activities—hamfests, auctions, contests, club building projects, GOOD speakers, demonstrations, participation in Field Day or VHF Parties, a good newsletter—can attract plenty of hams and prospective hams. Encourage newcomers: welcome them to the club, show them how to do things, give them old parts and tell them how to use them, invite them to visit your shack, teach them the code, give them old books and magazines (they can have a free sample of 73 if they write us), give them good advice, encourage them and set a good example. You'll find that it won't be long before they're pretty good hams. Hamming is a social hobby. It's more fun with other hams to visit and work with than with just talk on the air. There's no substitute for personal contact and encouragement.

And in line with this need to help n hams, I mentioned in May that we at 73 c answer the many technical questions we from the readers. K6HPR suggested that m be he and a number of EE's or other quali hams would be willing to help answer qu tions about ham radio. If you'd like to h out and think you can, why not send y name and qualifications in and we'll see w can be done. Maybe each month we co publish a list of people willing to help It might take a lot of time, but the work be very rewarding.

The ARRL Handbook and semiconductors

I often read and use the ARRL Amat Radio Handbook. If any single publicat could be considered the "bible" of amat radio, it must be the Handbook.* I can imagine any ham shack without at least of its many editions, and most hams seem get a new one every few years. But there one thing about the Handbook that both me. It's not that the Handbook seems m a textbook or project book than a handbo Or that the yearly editions are so similar. M radio theory changes very slowly, if at and the main object of the book is to prov a useful reference with enough change to courage hams to buy a new copy every years.

But I really am bothered by the Handboo treatment of semiconductors. Why does it tually ignore most current communicati practice? Any casual observer of electro can see that semiconductors have been are being accepted by all branches of el tronics as rapidly as economics, performa and (most important) engineering talent all The reasons are obvious. Semiconductors h many advantages over tubes for most u

(Continued on page 118)

*The ARRL refers to QST as the bible, but that se a peculiar analogy to me.

Copt. Glen Bentz WA4KIH/AFB4KIH
Major George Dodge W4OPL/AF4OPL
Rt 2, Box 53
Charleston Heights, S.C.

MARS HF Mixer and Amplifiers

This mixer takes 80 to 10 meter input and puts out a kilowatt on 1.5 to 27 MHz for MARS operation.

If there is one thing most amateur transmitters are not, it is *truly* all band. Most hams who are introduced to the MARS program find that their equipment is not designed for operation outside the ham bands. This poses a problem: Do I alter my existing equipment? Do I attempt to use surplus equipment? Do I buy new equipment? Existing ham equipment can be altered in some cases but can it be altered without some losses in operating flexibility efficiency, etc.? Besides many operators do not wish to alter late model equipment. Using surplus gear is ok if you can find something late enough to be state of the art, sideband, and not a TVI generator. To buy new equipment with all band capability costs $$$ and you don't find that in the old junk box.

Glen and George are pilots in the Air Force. George designed both of the units and built the 60 watt amplifier. Glen built the mixer and the kilowatt amplifier, and wrote the project up.

Like many inventions, this circuit was devised out of necessity. This station was operating a low power all HAM BAND transmitter. Then came MARS and the necessity of being able to operate, preferably with some power, on frequencies other than those covered by a ham transmitter. The result could hardly be called a compromise. The unit designed and built gives any ham band transmitter truly all band, high power operation without alteration of the existing equipment. It will operate from 1.6 to 30 MHz, at legal maximum power, and best of all, most of the parts were dug out of a well stocked junk box.

Circuit description

The principle is simple and tried. The frequency converter is a device by which a frequency corresponding to the input signal i translated to the desired output frequency. frequency converter is also known as a fre-

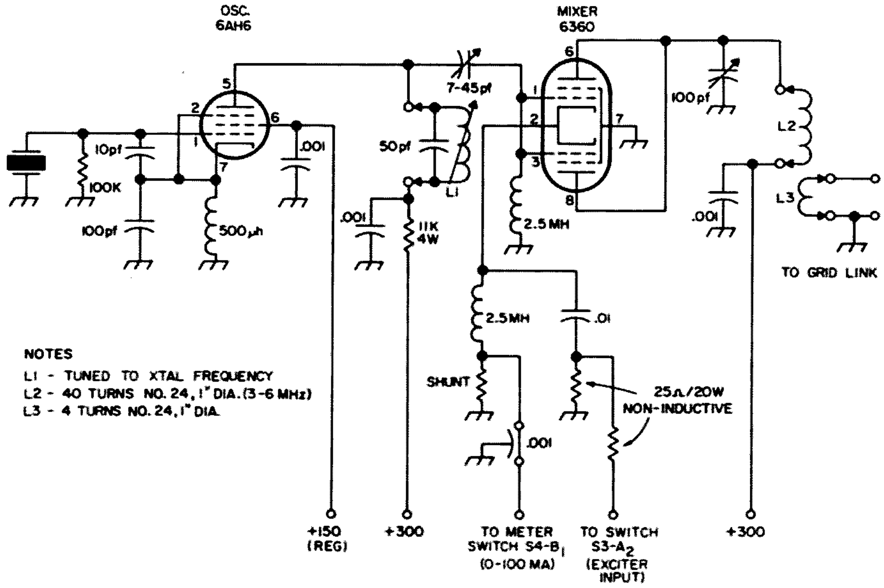


Fig. 1. Crystal oscillator and mixer that generates low level output to drive the final.

quency translator or frequency mixer. All these names are descriptive of the function in which two RF voltages are fed into a device hich produces a complex output wave from which the sum or difference frequency component may be selected. Normally, mixing or requency conversion takes place at low power levels, on the order of 500 mw to 1 watt. owever, in this particular instance the frequency conversion takes place at a considerably higher power, and is then further amplied.

The circuit is fairly straightforward and follows well established principles. The 6AH6 olpitts crystal oscillator was selected because of its excellent stability characteristics. Output from the oscillator is fed to the grid of a 6360, used as a mixer stage, through a variable trimmer condenser to facilitate mixer grid drive adjustment.

Selection of the mixer tube and circuit had to meet certain conditions: have sufficient output to drive an amplifier, be small in physical size, have high enough plate dissipation to idle with oscillator drive applied. The 6360 met all these conditions. With the screen and grids at DC ground the tube is biased below cut-off for operation in the non-linear region.

Since cathode drive must be about 20 times that required for grid drive, the oscillator sig-

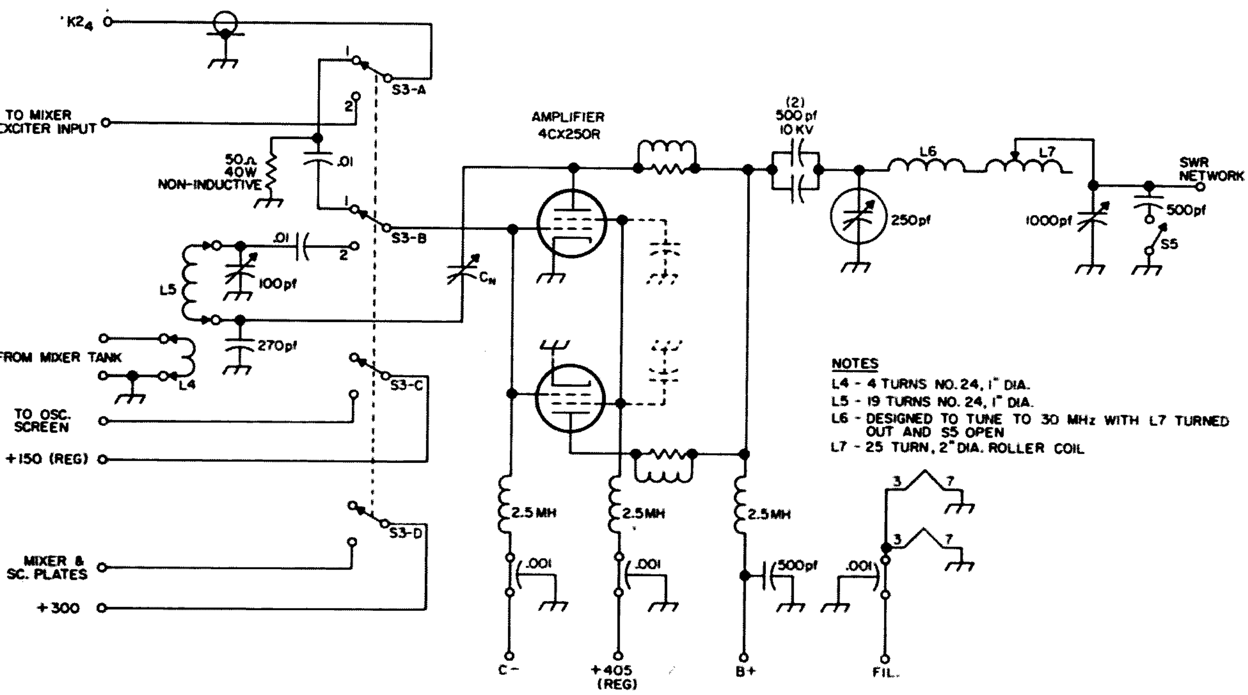


Fig. 2. 4CX250R kilowatt amplifier for HF MARS or ham frequencies.

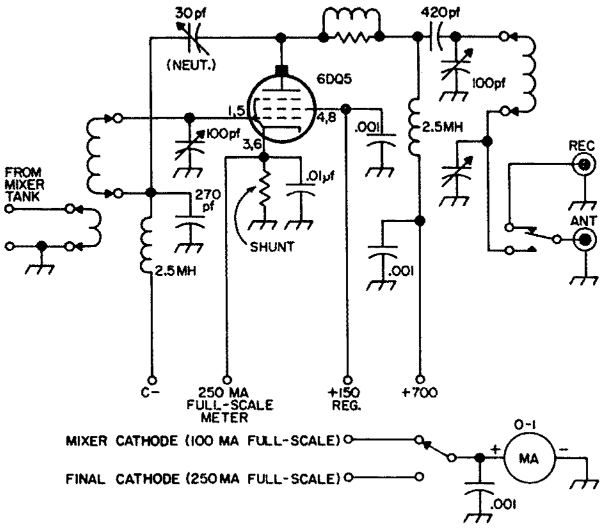


Fig. 3. "Low power" 6DQ5 amplifier for those who don't want or need a full kilowatt. The unmarked loading capacitor is 500 pf.

nal is fed to the grid and the exciter signal is fed to the cathode.

A combination of exciter impedance match, swamping, and signal voltage divider is used in the cathode input. The output of the mixer is link coupled to the amplifier grid tank. This was done for three reasons: an additional tuned circuit to further attenuate unwanted mixer products, isolation of the amplifier grid circuit, and ease of neutralization.

When the unit is used as a straight amplifier on the bands covered by the exciter, the oscillator screen and plate, and mixer plate voltages are switched off, the amplifier grid tank is switched out, and the exciter input is switched to a passive input network. The exciter now feeds through the passive network directly to the amplifier grid.

The amplifier section is a straightforward class AB1 linear employing a pair of 4CX250R tubes. The output is a pi-net using a modern vacuum variable, an ancient roller coil, and a standard variable capacitor.

The final touch was the addition of an SWR bridge. This is placed in the circuit such that it is usable even when the exciter is operated "bare foot." Bare foot operation is accomplished simply by not turning on the B+.

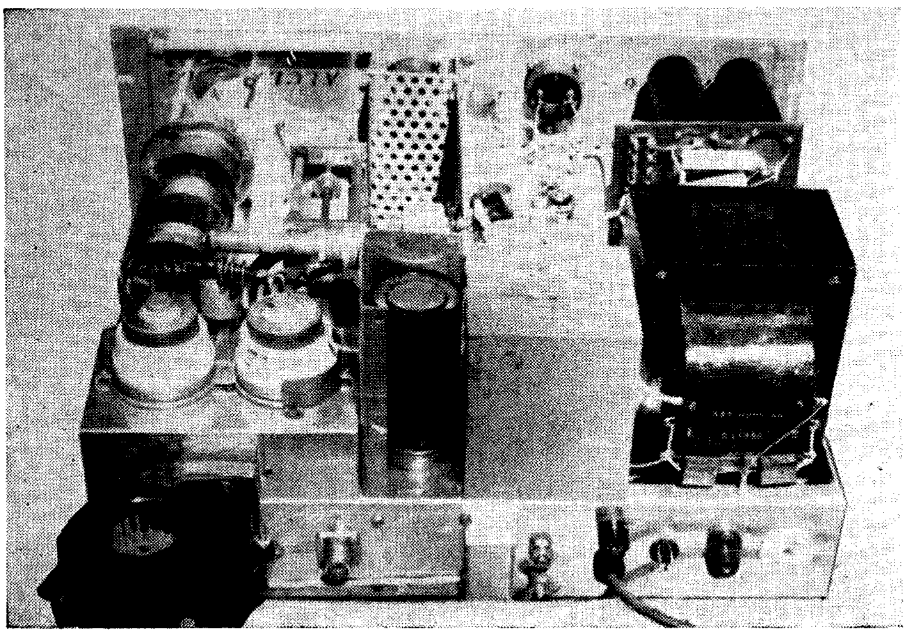
The power supply can be designed around the builder's junk box. The circuit shown utilized what was available at this station. A few items should be kept in mind. The screen supply to the 6AH6 and the 4CX250R should be regulated. The grid bias to the final must be adjustable to properly set the operating parameters for AB1 operation. The plates of the 6AH6 and 6360 should not exceed 300-VDC.

Construction

This particular unit was built on a 13x17x3" chassis. The vertical height was kept down to fit behind an 8¾ inch front panel.

The parts layout is shown in the photographs. The various sections are all shielded with solid aluminum sheet stock. The high voltage supply and final RF sections are shielded with perforated stock for personal protection from the power supply and RF shielding of the amplifier section. The final grid tank coil is mounted in a "tin" can. The lid being attached to the chassis around the coil socket, and the bottom of the can slipping onto the lid thereby completely shielding the coil unit.

Neutralization is accomplished with a stub



Back view of the high power mixer-amplifier.

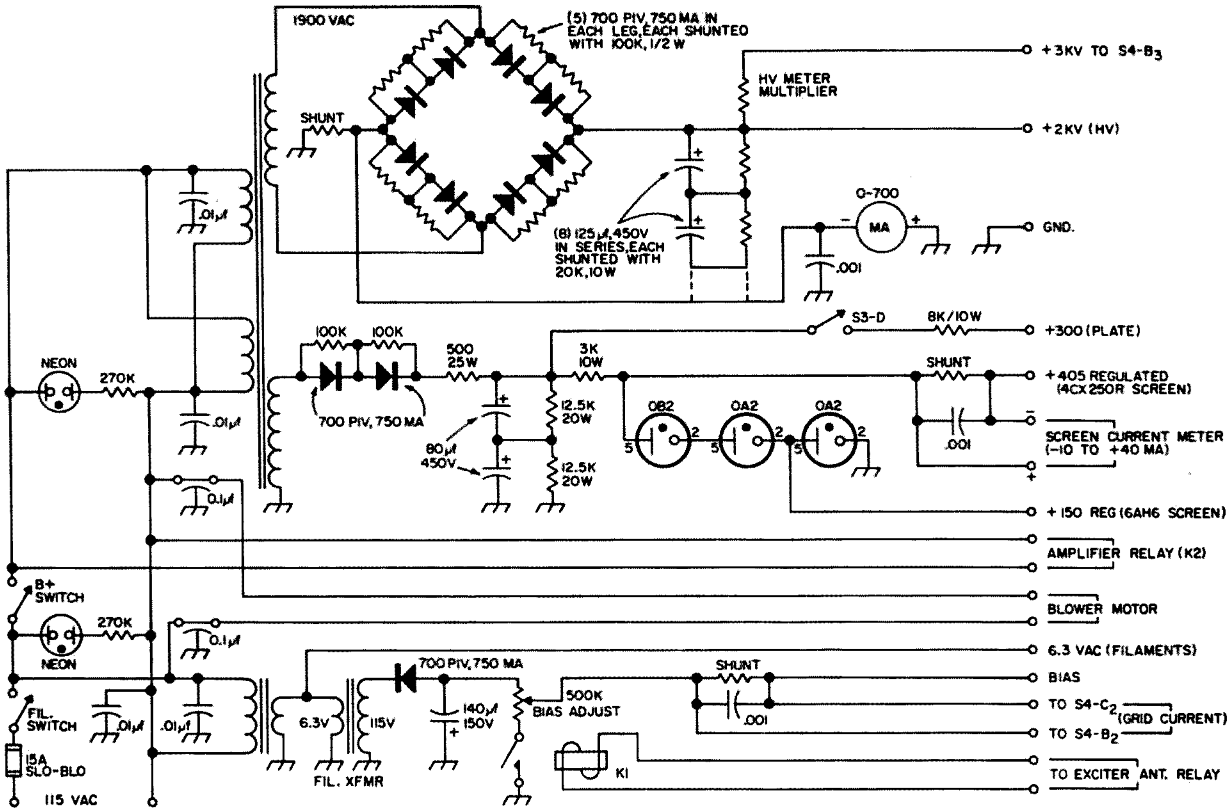


Fig. 4. Power supply for the mixer and high power amplifier. The bias pot marked 500 K should be 5K.

Output Frequency MHz	Crystal Frequency MHz	Exciter Frequency MHz
1.5— 2.1	12.5	14.0—14.6
2.0— 2.6	12.0	14.0—14.6
2.5— 3.1	11.5	14.0—14.6
3.0— 3.6	11.0	14.0—14.6
4.0— 4.6	10.0	14.0—14.6
4.5— 5.1	9.5	14.0—14.6
5.0— 5.6	9.0	14.0—14.6
5.5— 6.1	8.5	14.0—14.6
6.0— 6.6	10.0	3.4— 4.0
6.5— 7.1	10.5	3.4— 4.0
7.5— 8.1	11.5	3.4— 4.0
8.0— 8.6	12.0	3.4— 4.0
8.5— 9.1	12.5	21.0—21.6
9.0— 9.6	12.0	21.0—21.6
9.4—10.0	6.0	3.4— 4.0
9.9—10.5	6.5	3.4— 4.0
10.4—11.0	7.0	3.4— 4.0
10.9—11.5	7.5	3.4— 4.0
11.4—12.0	8.0	3.4— 4.0
11.9—12.5	8.5	3.4— 4.0
12.5—13.1	8.5	21.0—21.6
13.0—13.6	8.0	21.0—21.6
13.5—14.1	7.5	21.0—21.6
14.5—15.1	6.5	21.0—21.6
15.0—15.6	6.0	21.0—21.6
15.4—16.0	8.5	6.9— 7.5
15.9—16.5	9.0	6.9— 7.5
16.4—17.0	9.5	6.9— 7.5
16.9—17.5	10.0	6.9— 7.5
17.4—18.0	10.5	6.9— 7.5
17.9—18.5	11.0	6.9— 7.5
18.4—19.0	11.5	6.9— 7.5
18.9—19.5	12.0	6.9— 7.5
19.4—20.0	12.5	6.9— 7.5
19.5—20.7	9.0	28.5—29.7
20.5—21.7	8.0	28.5—29.7
21.5—22.7	7.0	28.5—29.7
22.5—23.7	6.0	28.5—29.7
23.5—24.1	9.5	14.0—14.6
24.0—24.6	10.0	14.0—14.6
24.5—25.1	10.5	14.0—14.6
25.0—25.6	11.0	14.0—14.6
25.5—26.1	11.5	14.0—14.6
26.0—26.6	12.0	14.0—14.6
26.5—27.1	12.5	14.0—14.6

of wire positioned near the plate of the 4CX-250R, but shielded from the base and screen grid of the tubes.

Coil dimensions are given only as a rough guide, as these will vary with builder's layout, parts placement, frequency requirements, etc. A grid dipper should be used for adjustment of all coils.

Selection of the crystal frequency will depend upon the exciter injection and the output frequency desired. In order to have unwanted mixer products attenuated as much as possible the oscillator and exciter frequencies must be as far as possible from the desired output frequency. The frequency table shows a list of crystal, exciter, and output frequencies that meet these requirements.

First, using a grid dipper adjust the oscillator coil to resonate at the crystal frequency. Then adjust the mixer tank to resonate at the desired output frequency. Apply power to the oscillator and mixer sections only. Check the oscillator for resonance and adjust the trimmer to drive the mixer to 20-25 ma. Next, inject the signal from the exciter until the mixer plate reads 40-50 ma. Then tune the mixer coil for maximum on the desired output frequency. NOTE: No dip in the mixer plate current will be found at the desired output frequency. Since there will be dips at other frequencies, some output indicating device

must be used to tune for maximum, such as a pilot bulb and a loop of wire, or neon light.

Next, the grid circuit of the amplifier should be resonated for maximum output, WITHOUT PLATE OR SCREEN VOLTAGE TO THE FINAL. Now the amplifier must be neutralized. With a sensitive output indicator (RF probe and VTVM was used) tune the final to maximum output. Adjust the position and length of the neutralizing stub to obtain minimum feed-through, keeping the grid and final tanks at resonance.

After neutralizing is complete the screen and plate leads may be connected and power applied to the final without exciter input. At this time set the static plate current to 140 ma by adjusting the bias control pot. The amplifier may now be loaded into a 50 ohm dummy or antenna. Without drive from the exciter, the oscillator is adjusted to resonate by a peak on the mixer plate meter at 20-25 mils. Drive from the exciter is then adjusted to 40-50 mils on the mixer plate current. Using the grid tuning condenser load the 4CX250R's to 500 mils keeping the screen current at or below 0 ma. The screen current will read slightly below 0 ma until approaching maximum output. It will then drop to below −10 ma, then increase rapidly. Load to 0 ma screen current and to 500 ma plate current keeping the final at resonance with reference to the relative power output meter. When operating SSB, screen current should not be allowed to peak above +2 ma.

When using only the amplifier straight-through on ham bands, switch off the power to the oscillator and mixer sections. The exciter then provides the drive and tune up procedures remain the same for the final.

Using the parameters mentioned above the power output of this unit was measured at 650 watts into a 50 ohm antenna. Attenuation of unwanted signal products was found to be 25 db or better down.

Conclusion

This particular unit is the end result of three units designed and built using these mixer principles. The second unit could well be of interest in cases where a smaller low power unit may be desired. That particular unit is designed in the same manner except it has no provision for straight amplifier operation and it uses one 6DQ5 tube operating AB1 linear. Using essentially the same circuitry, the operating parameters for the 6DQ5 are: 700 VDC on the plate, 150 VRDC on the screen, 20 ma static plate current, load to 150 ma. This gives an input of about 150 watts PEP and a measured output of 60 watts into a 50 ohm antenna.

Both units are being operated on AM and SSB. The smaller unit is also being operated on RTTY and is used both bare foot and to drive a Heathkit SB-200 amplifier. These units both put out a beautiful clean, clear, and faithful reproduction of the exciter signal. The larger unit is dual purpose for those who do not already have a KW final. The smaller unit can be used where the station does not require high power. Either unit will make any amateur band transmitter truly all band. So pick a rock, sling an antenna, and we'll see you around the bands.

. . . WA4KIH, W4OPL

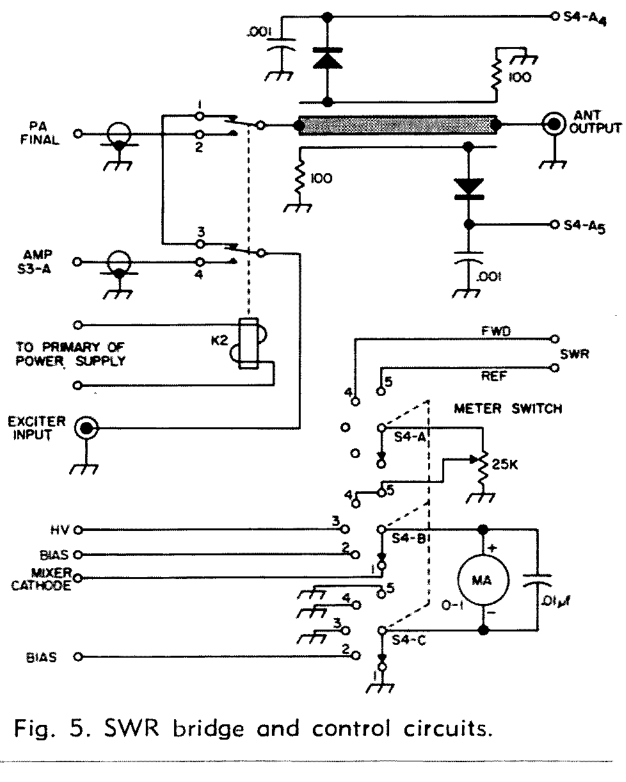


Fig. 5. SWR bridge and control circuits.

Build this shortened beam easily and inexpensively and get excellent results.

Terry Shankland WA8MVR
270 Fleming Rd.
Cincinnati, Ohio 45215

Simple Two Element Weeping Willow for Fifteen

What is a Weeping Willow? Just a yagi with bent elements, making it half as wide as it would normally be. Will it work? Well, the first time I put it on the air I got a new country, Ireland, 5X9 on 15 meters. Another Irish ham called me when I finished with the first, a situation to which I am not accustomed (he gave me 5X9, too). This was early in the morning, when the East dominates 15. Listening to a WB6, I found that his signal dropped about 3 S units off the side and nearly 4 units off the back. Satisfied? Read on.

I have a lousy location. In any direction, the antenna faces houses and fifty-foot tall trees. There is a hill peak about sixty yards to the west. My 40 meter dipole at forty feet did a fair job. However, I wished for something more. My two hundred watts PEP couldn't hold its own. The Weeping Willow, even at its present height of only twenty feet, gives me several advantages, among them:

1. Rotatability: Ever wished that you could rotate your dipole to get a lobe on a good DX station?
2. Unidirectionality: It sure is wonderful to cut down those Sixes when I want to hear Europe. And that gain! Less QRM coming in and more oomph going out.
3. Small size: If your mounting area is as small as mine, you will appreciate the size of this antenna. I have a hole in the trees that is barely big enough for a 6 meter beam, much less a 15 meter beam. This antenna has the width of a quad with one-half the height. The turning radius is only seven feet.
4. Low cost! Even if you must buy all the materials involved, the cost should be about fifteen dollars. This isn't bad for what you get.

Terry is a senior in high school and he'll enter Brown University in the Fall. He likes to DX.

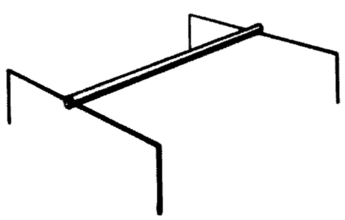


Fig. 1. Configuration of the elements of the weeping willow.

The Weeping Willow is formed as in **Fig. 1.** This antenna was mentioned in an article about a quad[1]. The elements are the same length as those of a yagi. However, one-fourth of the element's length on each end is bent downward 90°. Thus, my 15 meter version is approximately eleven feet across instead of twenty-two, and five and one half feet tall. Of course, this bending makes a 15 meter version a one band antenna. For those so inclined, a 20 and 10 meter antenna could be built with traps at the bends, a two band antenna the size of a 10 meter beam (how about a 40 and 20 version; it's only thirty-three feet across). Mine is two element because of the size and cost, but you might like three or more. I used .15 wavelength spacing between elements as recommended by the ARRL *Antenna Book*. The antenna in the picture cost me about $2.15 because I had almost all of the necessary materials on hand. There is only one big requirement to be met with my version: the elements must be above ground on the metal boom. This is not due to the antenna design, but to the matching section described later. A gamma or "T" match would not have this restriction. For anyone who does not have the materials I used, the possibility of a wooden boom might be investigated. A list of the dimensions for those who do not have a handbook:

$$\text{driven element (in feet)} = \frac{468}{\text{freq. in MHz}}$$

reflector (at .15 wavelength spacing)—

[1]David Morgan, K6DDO, "Three Elements on Three Bands," 73, July, 1963, P. 62.

: 15 meter weeping willow over WA8MVR's
use.

$$\frac{501}{\text{freq. in MHz}} \text{ (length in feet)}$$

There shouldn't be much of a problem in ilding this antenna. All that is necessary is lay out the tubing, cut to length, bend in : proper places, fit together, mount, and run the mast. My antenna went together with major mishaps (very unusual) and only ɜ mistake (the driven element is bent ghtly too far in). I hasten to add that this s the first antenna that I have ever built :h the exception of my dipole. Anyone word about duplicating my feat, forget it; if I ı do it, you can too.

Now for that match. It is quite simple, costs le, radiates well, and needs only one adjustnt. I took this straight out of an old 73[2]. r those of you without that issue, here are : instructions (maybe Fig. 2 will help):

Cut a length of RG8/U to the formula

$$\frac{234}{\text{freq. in MHz}} = \text{length in feet}$$

Determine exact center and cut off the outside cover for about an inch in each direction. Do *not* slice the coax in half. Now, cut the braid at the exact center (the braid only, please) and gather each side of the braid into a clump. To this you can solder the feedline (RG8/U) or an SO-239 female coax connector. I just soldered the feedline; you may not want so permanent an installation.

Now trim the insulation on the ends of the line. Solder the braid to the center conductor at each end.

Tape all exposed joints well so that they will not be affected by weather. You now have a ½ wavelength folded dipole.

This match has several advantages, but also requires a few things of the builder. First, it would be best if you mounted this match inside the tubing of the driven element. W6NAT says that you can mount it on the outside of the tubing if it is larger than the i.d. of the tubing, but it is best to put the match inside. Second, the driven element must be cut into two halves. Just slice it in the middle and mount as two pieces a few inches apart (this also helps if you want to mount the match inside the tubing). The ends of the match will just about reach the bends in the elements. This requirement should not bother a person homebrewing the beam, anyway. Third, the elements must be mounted above ground or the metal boom as already mentioned. Last, a 100 pf variable capacitor must be mounted in series with the center conductor to tune out the reactance. I use a Matchbox and this does the job for me. The capacitor can be mounted at the antenna or the transmitter. Please consult the article by W6NAT if you become thoroughly confused.

By now, all the OT's with six element beams and eighty-foot towers must be howling at my misadventures. I wrote this article not for them, but for people like me. I had never built an antenna such as this one. Money does not flow in plentitude from my pockets (I did have a summer job which paid for an SSB transmitter, though). There is only one small hole in which I can mount an antenna. To tell the truth, I was afraid that my efforts would end with the world's biggest lemon (I'm only seventeen and not yet full of the confidence of years). However, the Weeping Willow went together easily, which was a miracle, and works fine. I must add that I have not tuned it at all. I just built it and put it up. Who knows what could happen if someone would really try to match it to perfection. I don't know the exact gain or front-to-back ratio, but the antenna fulfills all of my hopes. Right now it is only twenty feet above the ground, but it easily outperforms my forty-foot high dipole. I can't wait to get it up to forty feet.

. . . WA8MVR

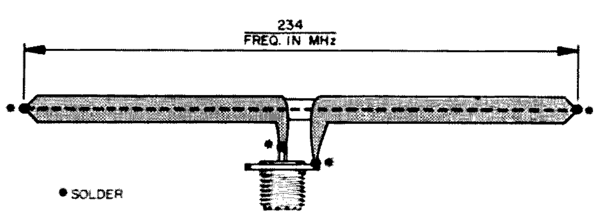


Fig. 2. W6NAT's infinite impedance match as used in the weeping willow.

[2] Bill Driml, W6NAT, "Infinite Impedance Antenna ıtch," 73, March, 1963, PP. 20-21.

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Precision Frequency Measurements for the Amateur

A general discussion of accurate frequency for hams with practical notes on reception of very low frequency transmissions.

The expanding uses of radio have forced tighter accuracy and stability tolerance on every radio service, including the amateur. Rigid frequency tolerance specifications have necessarily produced new components, systems and measurement techniques. It is now possible to measure frequency to a higher degree of accuracy than any other physical quantity.

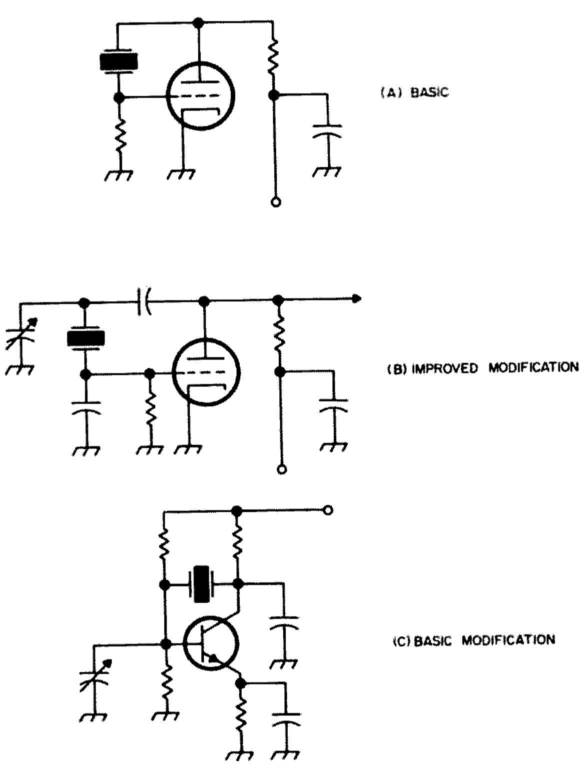


Fig. 1. Basic Pierce crystal oscillators. Values of resistors and capacitors will naturally depend on the individual tube or transistors used.

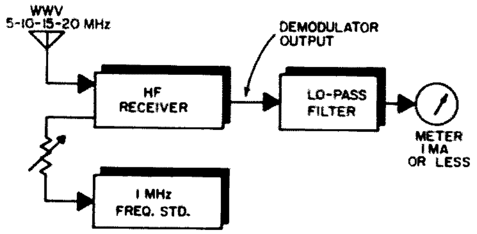
A logical question is: Does amateur radio need precise frequency measurements? This leads to: Just what does *precise* mean, as used here? Faced with questions like these, the measurements man on the receiving end of them invariably asks: What are the requirements?

Amateurs have often led in the development of communications techniques and have adapted complex systems to their needs. FCC regulations require that each amateur station maintain a means of measuring the transmiter frequency, independent of the transmitter frequency control. Depending upon the requirements this might be a temperature controlled quartz crystal, a calibrated receiver or even an absorption wavemeter. What are you using?

Accurate frequency measurements might be justified simply to protect the licensee against possible FCC citations. On the positive side they are useful for setting up nets and making them easy to operate, for schedules to put transmitters and receivers right on the spot for immediate CW, sideband, or teletype contact, or for making quick, accurate frequency changes to a hole in crowded bands. For the technical experimenter and builder they are especially useful.

A sideband carrier frequency may be operated within ten hertz of the band edge if it will stay there, and the reduced carrier ade-

Note: Hertz is now the "approved" term for cycles per second. Thus, Hz is equivalent to cps, kHz to kc, and MHz to mc.



g. 2. Frequency comparison using high frequency ansmissions from WWV.

uately suppressed. Unless the real stability of ıe generated carrier is known with confi- ence such operation would be unwise. Ques- onable performance of a costly sideband ystem may result from frequency shifts that ıust be measured in hertz. Most owners of ıch equipment having such trouble would robably return it to the factory with instruc- ons to "make it work or send my money ack", or perhaps "no more payements".

The plus or minus 20 hertz stability re- uirement for good sideband performance and erfect duplexing is only one part in 100,000 tolerance 1 x 10^{-5}) at 2 MHz. In the 10 ıeter band it is 2/3 part in 10^6 or 6.7 parts ı 10^7. This accuracy can be accomplished by sing as a reference equipment made with urplus parts in modern circuits. It is so imple and easy to have a frequency standard nd accessories of this capability these days hat there is no reason to be without such seful gear.

Unfortunately, we can not buy apparatus vhich a manufacturer can guarantee unre- ervedly as producing a refrence frequency of his order, whether we buy it in one piece or ut it together. A reliable source of correct requency is needed to put the gear "on the ıose" and keep it there. To maintain the toler- nces mentioned hams may use their old riend WWV.

Like everything else, WWV services have een improved, but radio propagation char- cteristics have not. Calibration instructions vhich usually read something like "adjust the eceiver for clear reception of WWV" suggest he recipe for rabbit stew which begins, "first atch your rabbit". In spite of the fact that he emmissions leave the transmitter accurate o a part in 10^{10}, and are maintained very tably, the average comparison against WWV s reliable only to a part or two in 10^7. By tudying the problem, choosing the best re- eived frequency and the best time of day, ccuracy of the order of a few parts in 10^8 nay be established—if the crystal oscillator lso has this order of stability. The ordinary veryday sort of beat comparison with WWV is suitable for most amateur crystal standards used for reference.

With a stable oscillator being compared at any of the WWV frequencies, except perhaps 20 or 25 MHz, an aural beat is not close enough. Under most conditions a zero beat is not reliable. Most ears are quite unselective below about 60 Hz; besides it is sometimes hard to decide between a slow beat and a fade. The simplest substitute is a sensitive milliammeter connected to the demodulator output through a filter with a cut-off fre- quency somewhere below about 10 Hz. Usually a resistor of about 47k ohms and a capacitor of about 0.5 μF will do the job.

Military communications, navigation sys- tems, timing systems for rocketry and space vehicles have need for better reference sources. Such activities often require controls that must be maintained within a part in a billion (1 p/10^9) or better. WWV high fre- quency broadcasts are useless for calibrating such precise systems because of the influence of propagation conditions. Means that have been developed for providing suitable refer- ences also provide the amateur with highly reliable, easy to use, standard frequency trans- missions.

A bit of history and a discussion of recent developments form a necessary prelude to the information to follow. So to proceed as briefly as possible. There was a time when all but a small portion of wireless communications was done with wave lengths of 30,000 to 10,000 meters. We now say 10 kHz to 30 kHz and call this band *very low frequency (VLF)*. The *low frequency (LF)* band is 30 to 300 kHz. The Navy has long used VLF and maintains several transmitters in the band below 30 kHz. They are able to communicate world wide when magnetic or ionospheric storms disable the higher frequencies. Because of the nature of those emissions modern equipment in sub- marines can receive them while submerged. Systems have been developed for stabilizing

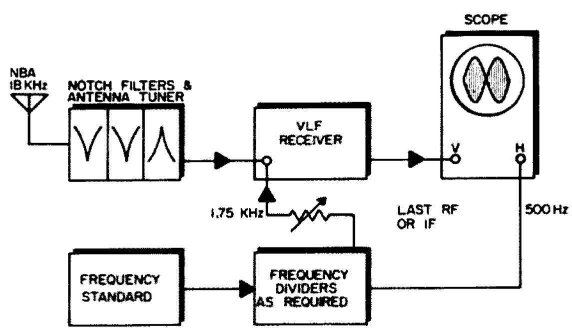


Fig. 3. Frequency comparison using very low fre- quency transmissions. See Figs. 4 and 5 for the notch filters and VLF receiver.

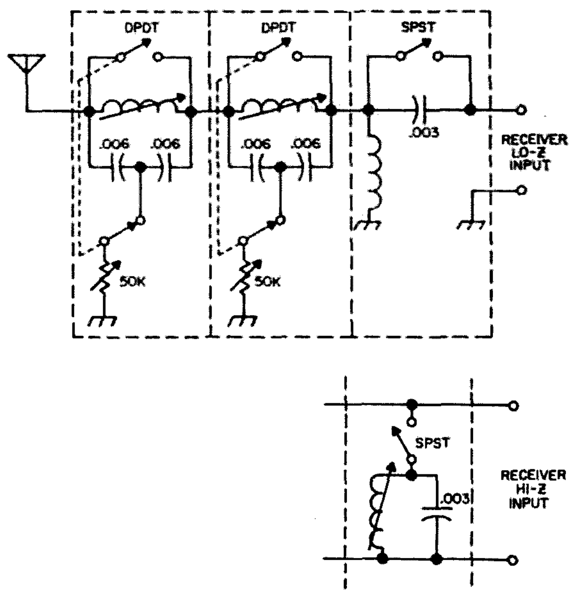


Fig. 4. 18 to 20 kHz notch filter and antenna tuner for high and low impedance receiver inputs. The coils are Miller 6315.

the frequencies of these stations so that they vary no more than 1 p/10^{10} per day about a nominal frequency known to a few parts in 10^{11}.

The basis of accurate frequency is a stable time reference. Frequency and unit of time are inseparable. One may be defined in terms of the other.

For more than a century the Naval Observatory has been the custodian of time for the United States. With the Naval Research Laboratory, the National Physical Laboratory of Britain, and private investigators like J.A. Pierce of Crufts Laboratory, Harvard, they conducted long distance tests by VLF over a period of several years. The results led to the establishment of the Ephemeris second, based on the earth's orbital motion, as the time interval for scientific work. They also determined the resonant frequency of a nuclear energy transistion of the element cesium in terms of the Ephemeris second. This led to establishment of an international system of atomic time in which the period of 9,192,-631,770 cycles of cesium resonant oscillation is one second. No longer is the turning of the earth on its axis a suitable time reference. By comparison with the other references the earth wobbles along like a sprung buggy wheel rolling on a rutty road.

Station NBA in Panama and other Navy stations are continuously monitored by the Naval Observatory and the Naval Research Laboratory to maintain them accurately on frequency. Naval stations ashore and afloat have receiving systems which use these stations to maintain their frequency standards accu continuously to the least 1 p/10^9.

At mid-1965 the Navy stations using V all with power output from 100 kilowatt 1 megawatt. are as follows:

NAA	Cutler, Maine	17.8 kHz*
NBA	Summit, Panama	24.0 kHz
NPG	Jim Creek, Wash	18.6 kHz
NPM	Honolulu, Hawaii	26.1 kHz
NSS	Annapolis, Md	21.4 kHz

*alternates hourly with FSK (or ot phase shifted emissions) and Morse t graph.

Now—the relationship to the amateur o ator. By the method described for HF rec tion, a quite ordinary VLF receiver is means to very accurate frequency comparis with these stations, almost any time, day night. The only restrictions on the amate accuracy of comparison are the stability his standard oscillator, and how long he willing to watch a meter or oscilloscope time a beat or note a change.

The oscillator will have to be used wit set of multivibrators or other frequency d ders to produce output at one hertz har nics which are used to beat with the V stations. Should one of them use 18 k (once used by NBA), a cycle on this quency occurs in 55.5 microseconds. A mill cycles occur in 55.5 seconds. So, if the b meter pointer moves across the scale (or scope pattern moves), a half cycle in 56 s onds—and maintains this rate—the oscill under comparison is accurate and stable t part in 10^6. A full beat in 9 minutes, seconds, or a half beat in 4 minutes, 38 s onds, represents 1 part in 10^7.

More versatile, though a bit more comp systems for amateur use are developed fr methods suggested by Hastings and Stone June 1961 NRL Report. These have b used to meet the needs of ship-yards, pend production of a military model of a V phase tracking system. They have proved be adequate as an interim method for c brating the most precise Navy Freque Standards.

Virgil Neher W6KT, has had a long ti interest in frequency measurement. A f

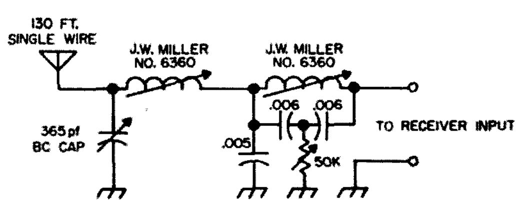


Fig. 5. Antenna tuner and notch filter for 14.5 25 kHz.

years ago, W6OC and W6KT had a session on the various methods of measurement, for the amateur. W6KT produced a progressive series of receiving devices for calibrating a precision oscillator, which was a product of the relationship. The stability performance of his oscillator approaches closely some of the better commercially available products. It seems that it may be very easily classed as a 1 p/^{10} per day unit, and since mid-1965 the ageing rate has decreased until it is not observable with the methods in use. A clock driven by such an oscillator would keep time within a second in three years or more.

Such a fine oscillator is not necessary for amateur requirements. A reasonably good quartz crystal in a good circuit, well constructed, will fill amateur radio needs. Most quality oscillators available today use what is known as a "Warner" crystal, in some variation of the well known "Pierce" circuit. The conformation of most of these has led to their being called "Crystal Colpitts". An article on this development with respect to self excited circuits is listed last in the bibliography.

The basic "Pierce" circuit and the simplest form of current tube and transistor modifications are shown in **Fig. 1.** Crystals operate series resonant in these circuits. Among common mass produced crystals for transmitter or receiving conrol, those operating very close to a specified frequency at parallel resonance, have been known to operate as much as 0.1% higher in a "Pierce" circuit. In general, shunt trimmers have very little effect on the frequency of oscillation, so may be used for very fine adjustment.

Surplus 1 MHz crystals of excellent quality for amateur purposes have been available for as little as 2 for $2.35. Several sources advertise such crystals for about $2 or $3. Some 100 kHz crystals have been available at slightly higher prices. A good check of the ads in the magazines will bring some worthwhile results when looking for bargain crystals.

To the good crystal oscillator just discussed, add some sort of divider string to come out with 1 kHz and if you want to go first class, 100 Hz. Also latch on to an oscilloscope which has provision for locking, driving, or triggering the sweep externally. The handbooks describe the latest versions of the old standby frequency divider, the multivibrator. Many amateurs today meet flip-flops, and phanyastron circuits in their daily work. These can hardly be kept from working if wired correctly. Just put them together and drive with the standard oscillator.

For NBA on 18 kHz Virgil W6KT, coupled the 17.5 kHz harmonic of a 2500 hertz output to the antenna of the receiver. The receiver has no audio detector (though one can be useful). The yield from the last rf (or *if*) stage is applied to the vertical plates of the oscilloscope. Adjustment of the injected signal level is made to effect 100% modulation of the incoming 18 kHz signal. A carrier with 500 Hz envelope is developed. The 500 Hz harmonic of one of the lower frequency dividers is applied to the horizontal drive or directly to the horizontal input of the scope. Adjustments are made to display one cycle of the envelope on the CRT.

If the oscillator is sufficiently stable and on frequency the pattern will appear stopped. Actually it will move across the screen at a rate which is a measure of the difference between the standard and the reference VLF station. Virgil sets the zero of the modulation envelope (or cross-over point of the pattern if you like) at a vertical line on the face of the scope. He then checks the time in minutes or seconds for movement of the pattern some definite fraction of a cycle. For NBA (when on 18 kHz), movement of 1/10 cycle in 30 minutes indicates a deviation of about 3 parts in 10^9. The same movement of the pattern in about 36 seconds shows a deviation of $1.5/10^7$, about as good as the normal HF comparison against WWV.

The VLF and LF services of the National Bureau of Standards are extremely accurate but are not so easily received by amateur methods because of the relatively low radiated power. On 20 kHz the output of WWVL

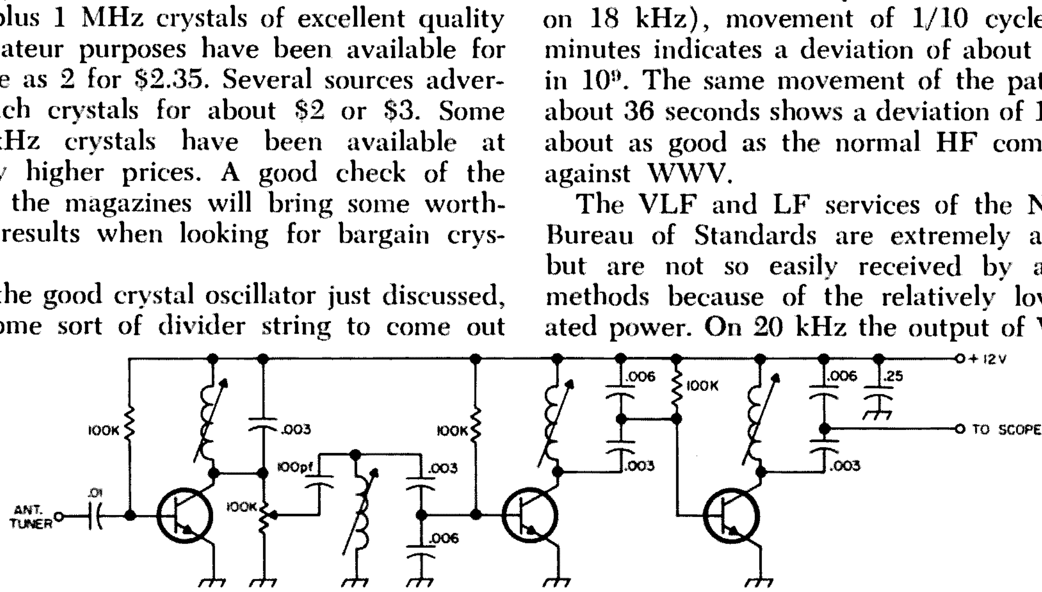


Fig. 6. Tuned amplifier for 18 or 20 kHz. The coils, which should be shielded, are Miller 6210 or Miller 6315. Transistors are 2N1149, etc. The 100 k resistors should be adjusted for about 1 ma collector current in each transistor.

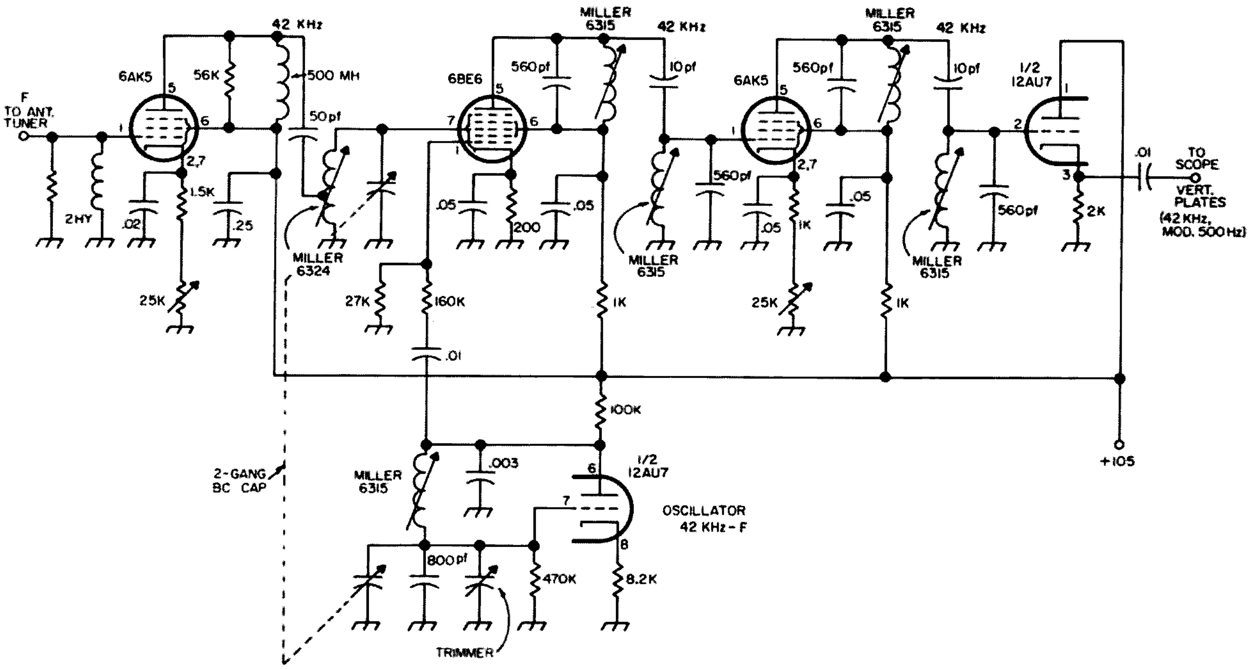


Fig. 7. VLF superhet receiver for 14.5 to 25 kHz. IF frequency is 42 kHz.

is about 1 kW; on 60 kHz WWVB radiates about 6 kW. Antennas and transmitting equipment are installed near Ft. Morgan, Colorado. Because of experimental and research work being conducted using special emissions using pulse, or phase or frequency shifted signals, it is not always possible to effect accurate frequency comparisons by simple methods. Subscription to the NBS bulletins relating to their standard frequency broadcasts may provide information in detail about the special emissions.

When the signal under control of the standard oscillator is injected into the antenna, the entire receiver must have band-width at least as great as the numerical value of the difference frequency. For NPG, 18.6 kHz, the injection may be 19 kHz and the pattern and scope deflection signals will be 400 Hz. For NPM, 26.1 kHz, 26 kHz injection makes the difference 100 Hz. Likewise, 18 kHz mixing with NAA, 17.8 kHz yields 200 Hz. VLF signals of even 1 kHz multiples like 18 or 24 kHz may be compared directly by applying the receiver rf output to the scope vertical plates and the divided standard frequency of the same value to the horizontal plates. Movement of the Lissajous pattern with time gives the deviation.

Since allocations in the VLF range are assigned at even 100 Hz intervals, interference can be a problem if the receiver is not sharp enough or filters of some sort are used. An antenna tuner sharpens the response and will improve the signal about 15 dB. If interference persists, one or more "Notch Filters" will usually clear it adequately.

For the serious "researching" amateur, a bibliography of reference material on precision frequency equipment and VLF transmission is provided at the end of this article.

. . . W6BLZ

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VHF Parametric Transistor Multipliers

In the March 1965 issue of "73", authors Firth and Olson described "The Parametric Transistor Multiplier,"—the combination of parametric diode multiplication and class "C" amplification in a single transistor. Now, co-author Olson shows how the technique can be extended to the VHF range, in a somewhat different mode that is more practical at the higher frequencies.

During the last year there has been considerable interest in the use of transistors as parametric multipliers. In fact, at least one semiconductor manufacturer has advertised a silicon power transistor that is specifically designed for parametric multiplication. R.C.A. has recently released its 2N4012 which, operating with 1 watt of 324 MHz drive, will produce 1.4 watts of 1296 MHz output.[1]

In a previous article in 73, a type of parametric multiplier was presented that utilized the emitter–base junction, of a transistor in a grounded-base, class–"C" amplifier.[2] The circuit was as in **Fig. 1**, a 3.5 MHz to 14 MHz quadrupler. This circuit is presented again for reference and to correctly show the idler frequencies—which were incorrectly labeled in the original figure. As can be seen, the amplification takes place *after* multiplication (at 14 MHz), since the idlers are across the emitter-base junction.

The original method of parametric transistor multiplication has in its favor: an easy-to-follow development from a circuit composed of a separate varactor multiplier and class "C" amplifier, and good load isolation.

In the VHF multiplier, we will reverse the order, letting class "C" amplification take place at the input frequency, and do the multiplication thereafter. This means that, now, the idlers will be across the base-collector junction, which acts as a non-linear capacitance.

The advantage of this configuration is that transistors can be used to produce output power that exceeds their input power, even though operating above their f_T. The disadvantage is that the idlers and output circuitry become one big network, which makes understanding more difficult and does not give load isolation.

An elementary VHF parametric multiplier is presented in **Fig 2**, showing the idler-output circuitry on the base-collector side of the transistor. Since the input impedance to a grounded-base stage of this type is low, one can actually use such an untuned input circuit during initial tests.

In designing a parametric multiplier, we ought to restrict ourselves to driving frequencies of lower than 1/3 the frequency at which the transistor has unity power gain, f_T. Also, only multiplication factors ("n") of two, three, four, and possibly five should be tried. Multipliers with "n" greater than five require too

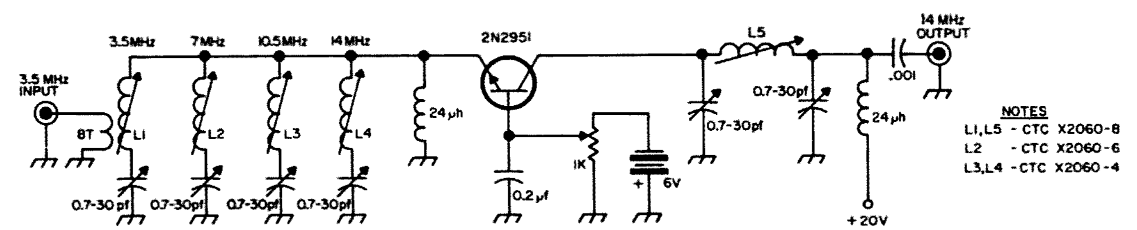


Fig. 1. High frequency parametric transistor multiplier. The multiplication (similar to that of a varactor) takes place in the emitter-base junction, then the transistor amplifies the signal at the multiplied frequency, 14 MHz.

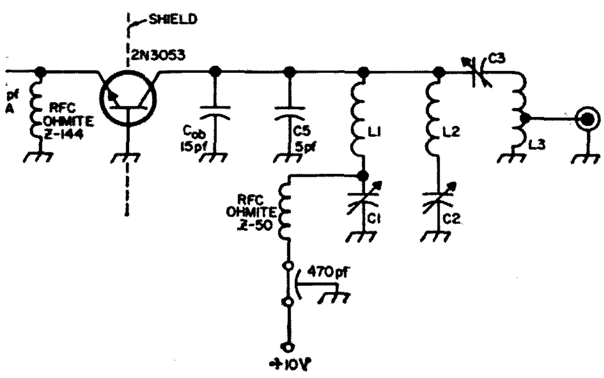


Fig. 2. 48 to 144 MHz parametric transistor multiplier. Note that this circuit is unlike the one in Fig. 1 in that the multiplication takes place in the base-collector junction. This is a preliminary circuit with untuned input. C5 is C_s, stray capacitance.

many idlers, and the calculation and implementation of such circuits gets out of hand. As an example, a transistor with an f_t of 120 MHz would best be driven with 36 MHz input and designed as a quadrupler, if 144 MHz output is desired.

Bear in mind that *the transistor must be operated at an input frequency where it has some power gain,* since all amplification goes on at the fundamental frequency. This fact is clearly shown in a recent R.C.A. application note (SMA-40), wherein a 2N4012 will typically put out less than 1 watt at 1296 MHz as tripler (with 1 watt of 432 MHz drive) but will put out 1.4 watts at 1296 MHz as a quadrupler (with 1 watt of 324 MHz drive)! This relation is shown in **Fig. 3.**

As a start, let's design (and gain experience with) a circuit which is inexpensive and forgiving, yet which will demonstrate all the little subtleties of VHF parametric multipliers. A transistor costing less than a dollar is used; it is *normally* used "in small signal applications up to 20 MHz." We will use a 2N3053 as a 48 MHz to 144 MHz tripler, and if there are any "semiconductor tragedies," at least we are not out much.

Looking at the 2N3053 spec. sheet, we find that it has a maximum gain-bandwidth product of 200 MHz, see **Fig. 4A.** The second fact that is apparent is that, unlike some of the "overlay" transistors, no curve of collector-base capacitance versus voltage is given. Since the collector-base capacitance (Cob) is a depletion-region capacitance, it should follow the same (exponential) curve as that for varactor diodes. We then can take the normalized capacitance-voltage curve from any varicap data sheet, plug in the one data point as given by our particular transistor spec. sheet for Cob; (15 pF at 10 volts for the 2N3053), and get the values of capacitance for any other voltage.

However, to simplify matters, suppose we make our first attempt at a collector of +10 volts, where Cob is known. This, also, gives an operation point that falls on the published Ec-Ic curves of the 2N3053, see **Fig. 4B.** If we decide on an average collector current of 30 mA, this puts our operating point approximately a third of the way between the 175 MHz and 200 MHz gain-bandwidth contours of figure 4a. This point is marked by an X, and gives us a gain-bandwidth product of approximately 180 MHz.

A 48 MHz to 144 MHz tripler easily fits within our criterion of 1/3 the f_T for a drive frequency. **Fig. 2** is such a tripler, simplified to make it easy to adjust initially. The effective output capacitance of the transistor is Cob plus Cs (a stray wiring capacitance of 5 pF), for a total of 20 pF.

L_1 and C_1, the 48 MHz idler, must be series resonant in combination with the 20 pf output capacitance. That is, **Fig. 5A** must resonate at 48 MHz. Similarly, **Fig. 5B** must resonate at 96 MHz, and **Fig. 5C** must resonate at 144 MHz. Or, at least, this is *nearly* true, since each idler's impedance at the other two frequencies modifies the design aim somewhat. Since we know that Cob+C_s is 20 pF, L_1 must be at least 0.6 μH to resonate at 48 MHz. Let's take L_1 to be 1.2 μH and make C_1=20 pF (a 3 to 30 pF trimmer in the actual case). In a similar way we make L_2=0.3 μH and C_2=20 pF. Then with the output series-circuit we must use a bit more caution, making L_3 relatively large in order that C_3 be small, so as not couple too much of the funda-

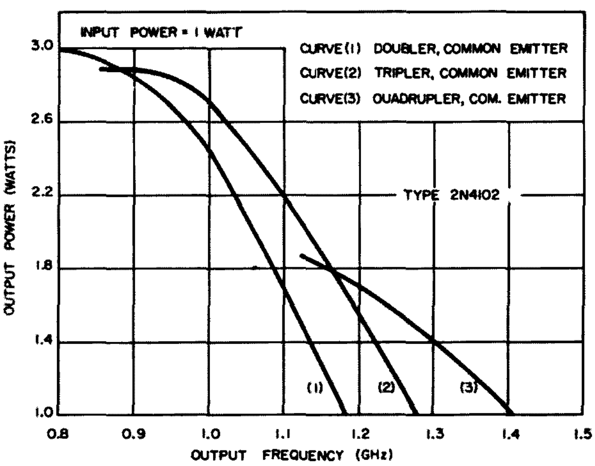


Fig. 3. Output of an RCA 2N4012 operated as a parametric transistor multiplier. Note that the 2N4012 will pu out more power at 1296 MHz as a quadrupler than as a tripler. The text explains this.

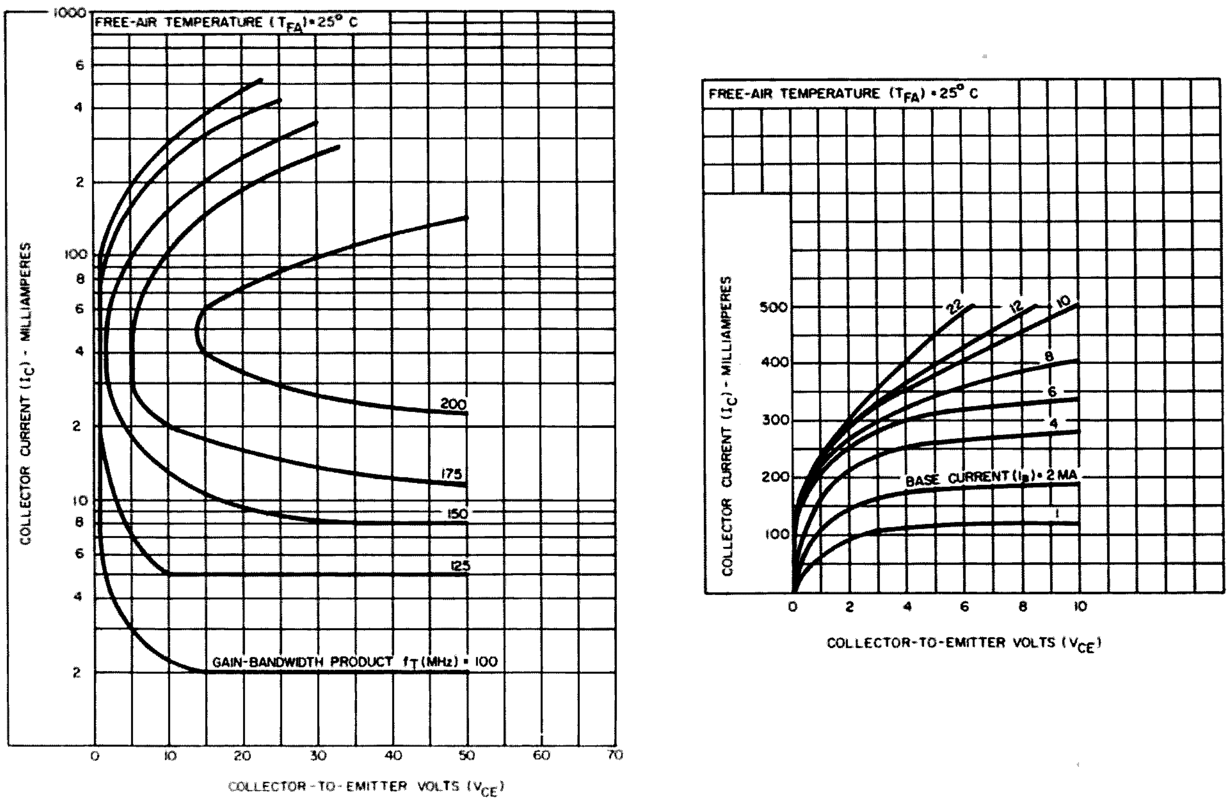


Fig. 4A. Gain-bandwidth curves for the RCA 2N3053 (a 96¢ transistor). Fig. 4B. Collector current (I_C) versus collector-emitter voltage (V_{CE}) for the 2N3053. Add an "X" at the junction of 10 on V_{CE} and 30 on I_C in A.

mental and 2nd harmonic to the output. L_3 is made 0.4 μH and C_3 is 3 pF, (a 3 to 12 pF trimmer). The output tap is deliberately placed very low on L_3, to cause small loading, during initial adjustment.

The 48 MHz, 50Ω output of a small (6 meter) exiter is coupled to the input of the multiplier, after the output of the multiplier is terminated in 50Ω. Increase the drive to no more than 10 volts rms and one should see the 2N3053 collector current climb from zero to our operating point of 30 mA. Using a grid dip meter as an absorbtion wave meter, couple it to L_3 and tune C_3 for the maximum 144 MHz output. Then tune C_2 for maximum 144 MHz output with the grid dip meter still coupled to L_3. And, similarly peak up C_1. The drive level will need readjusting (reducing) during this process. C_1, C_2, and C_3, should then be readjusted several more times for maximum 144 MHz output, until readjustment has a small effect.

At this point we will go back and put a matching transformer in the input, to optimize transfer of drive from the 50Ω driver to the 2N3053 emitter. Also, various taps on L_3 for optimum output loading are tried, each time retuning C_1, C_2 and C_3. Now, finally, that we've "juggled" and "tweaked" the whole thing up, the reader will begin to understand what he has in store if *large* multiplication ratios are involved.

As to the performance of the unit, it required 1.5 volts rms of 48 MHz drive at 50Ω. The 144 MHz output was 2.25 volts rms across 50Ω. The collector efficiency, then, is 33% (300 mW dc power input, 100 mW of 144 MHz output). To asure ourselves that the RF output voltage that was being measured is really predominantly 144 MHz, a look at it was taken with a highly specialized oscilloscope. The oscilloscope used was a "storage" scope with "sampling" plug-ins. Such a device allows one to look at repetitive waveforms up to 1,000 MHz and "store" that waveform image on the 'scope face, for leisurely examination and

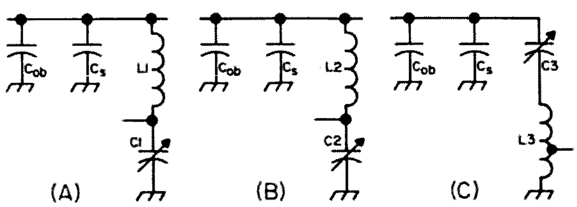
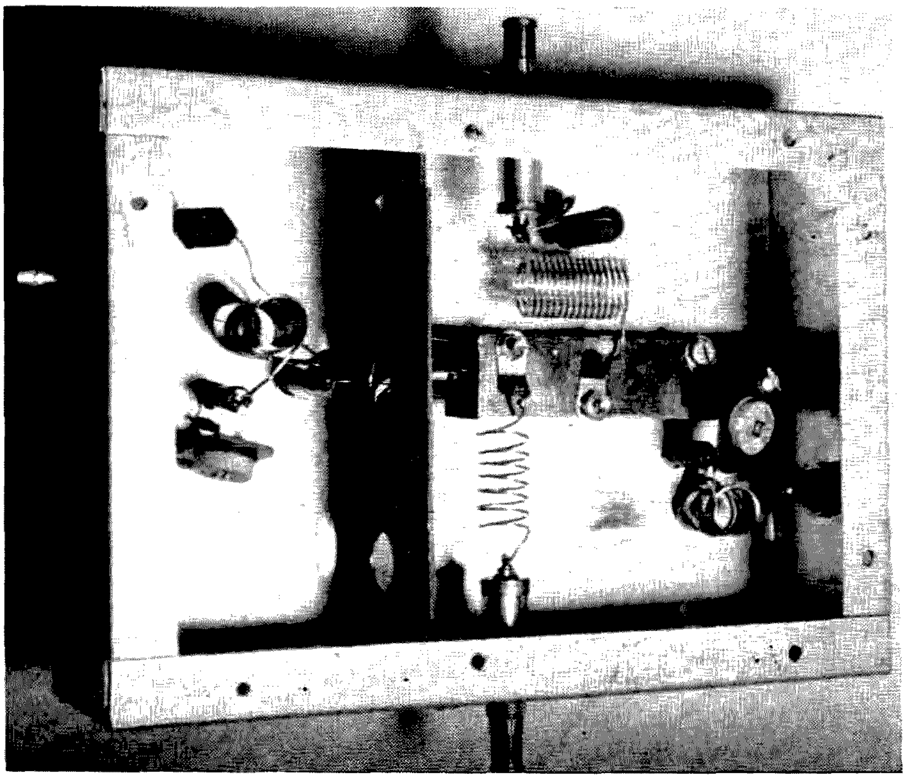


Fig. 5. Output circuit of the parametric transistor multiplier. In A, the resonance is at 48 MHz, in B, at 96 MHz, and in C, at 144 MHz.



Bottom view of the 48 to 144 MHz tripler in Fig. 7.

sketching. The waveform of the above unit is shown in **Fig. 6**, as it was sketched, from storage 'scope face. Three cycles of 144 MHz RF are displayed so that the amount of 48 MHz present can be observed. The fact that a rather special 'scope was used for making **Fig. 6** does not mean that it was essential, but its use only confirmed our other measurements. The grid dip meter was the only necessary piece of test equipment.

The final circuit is shown in **Fig. 7.** It was built inside a 5 X 7 X 2 aluminum chassis as shown in the photo. Note that the input circuit occupies occupies the 2½" compartment at one end of the chassis. The transistor is mechanically and electrically attached with an IERC TX 0507-1B heat sink to a 3 inch long piece of ¾" wide copper strap (the collector of a 2N3053 is connected to the case). This strap serves to dissipate heat, and also serves as a low inductance connection to the idlers. Note that the three coils for 48, 96, and 144 MHz are all spaced from each other and all at right angles to each other, to avoid inductive coupling. A bottom plate is used which completes the shielding of the input and output compartments. It has a ⅜" hole in it for adjustment of C_3 and a 1⅛" hole immediately above L_3, so that the grid dip meter can be coupled to that coil during adjustments.

A second unit was constructed to try the principle as a 144 MHz to 432 MHz tripler (**Fig. 8**). The transistor used in this case was a 2N3553 (R.C.A.) which was about $8.00 when purchased. The newer 2N3866 should

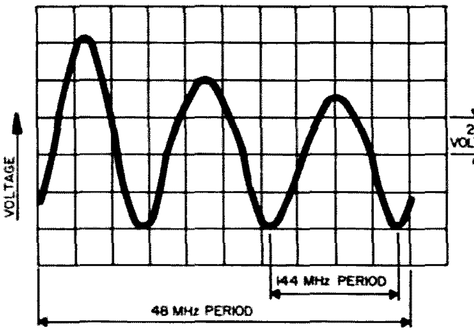


Fig. 6. Output waveform of the tripler in Fig. 7.

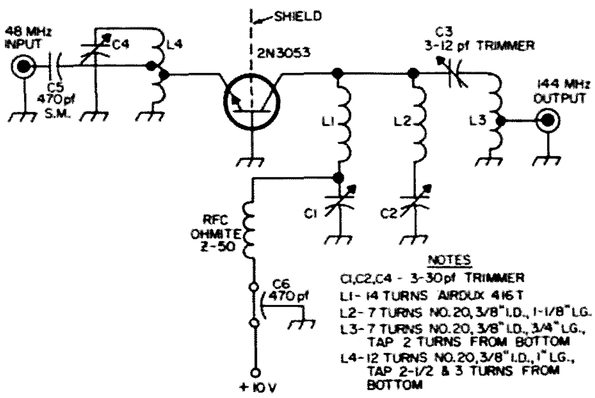


Fig. 7. Final circuit of the amplifier-tripler in Fig. 2. It puts out 100mW on two with 45 mW of 48 MHz drive and 300 mW dc input.

work as well and is only about $5.00. (the 2N3866 is now being manufactured by two other firms, which will tend to bring the price down).

The 432 MHz tripler was constructed in a smaller chassis, a Bud AC-431, measuring 4X6X2. It was partitioned, as before, and one will note the "wavelength scaling" throughout (ie: smaller inductances and smaller capacitances) in the photo of it. Note, also, that the copper heat sink tab had to be cut shorter than previously to reduce its inductance.

The output of the unit is 320 mW at 432 MHz with 180 mW of 144 MHz input. The DC input power was 12 volts at 50 mA, or 600 mW.

While the two parametric multipliers herein described are perhaps not pushing the state of the art, they do represent working models of a relatively new technique. No doubt the units shown can be driven harder, modified, etc.; but the experimentation and "smoke-testing" will be left to those interested in further work. As they stand, the circuits may be useful in handytalkies, or (offset a bit in frequency) as local oscillator chains.

What has been attempted above is to present an approximate method of designing a parametric-transistor-multiplier. The resultant circuits *do* work, though they are almost certain not to be optimum circuits. Since we can change drive level, operating voltage, C_1, L_1, C_2, L_2, C_3, L_3, and the tap on L_3; we can be said to be dealing with nine variables. The optimization of such an array is nearly hopeless theoretically, unless a digital computer is handy and you can set the nine equations in nine unknowns up for it.

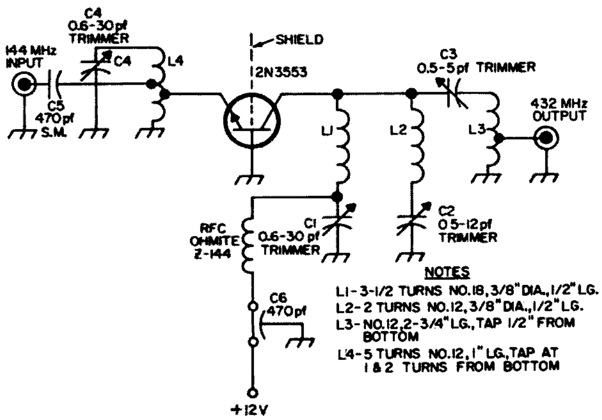


Fig. 8. Parametric transistor multiplier from 144 to 432 MHz. Output is 320 mW with 180 mW input on 144, with DC input of 600 mW (12 volts at 50 mA).

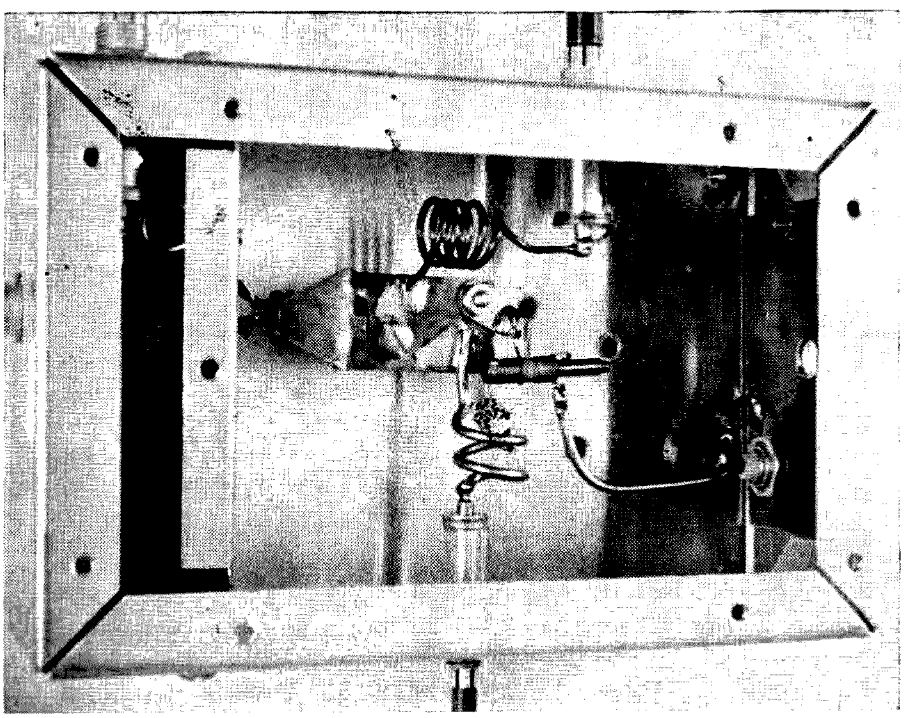
However, this approximation method does work—give it a try!

The author wishes to thank Radio Corporation of America for permission to use **Figs. 3** and **4.**

. . . W6GXN

Bibliography

1. Minton, R. and H. Lee. "Frequency Multiplication Using Overlay Transistors," RCA Application Note SMA-40. September 1965.
2. Firth, F. and H. Olson. "The Parametric Transistor Multiplier," 73, March 1965.



Bottom view of the 144 to 432 MHz tripler in Fig. 8.

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How To Get Your Extra Class License

With all the controversy about incentive licensing going around and the good possibility of the FCC making an extra class license necessary to enjoy full ham privileges, I guess many of us have given serious consideration lately to getting that extra class ticket. Any ham would be proud to have one of these licenses simply because of its prestige and the feeling of self-accomplishment that it gives. But until now, who has needed it? A general class license gives us full operating privileges now, so why go to a lot of trouble? This I'm sure is the attitude that most of us have taken, but now our thinking perhaps has changed in view of the recent developments. The thought of getting out the code practice oscillator and the theory books is not too pleasant to many of you, but let's say that you've told yourself that this is the thing to do and you've resigned yourself to getting that extra class ticket. Just what do we have to do to get it and where do we start? Well, we know that we will have to get our code speed up to 20 wpm and that we will have to bone up on some theory. Let's take a look at several ways that you might be able to do this.

Louis is an electronic engineer at Gulf Aerospace (BAS, Houston). He has a second class telegraph and first phone license as well as his extra class ham license, and has written many articles for many periodicals.

Code speed

If you are a regular CW man you are probably capable of about 20 wpm already, or you can't be too far away from it. Most of us don't really know exactly what speed we are capable of, so don't jump to any conclusions. Find out just where you stand and then do something about it if you have to. I guess the best way to check your speed is to use a commercial code machine set to 20 wpm. If there is none available to you, check in with ARRL station W1AW in the evenings. (See a recent issue of QST for times and frequencies.) They regularly transmit code at various speeds and make it easy for you to check your capability. You may be surprised to find that you can already receive 20 wpm or very close to it. If you're not quite there, start practicing.

If you're a phone man, then you've got another problem. The thought of having to copy code at 20 wpm is probably enough to make you throw up. But don't panic. If you once copied 13 wpm for your general class ticket, then you should be able to work back

up to and beyond that now. Before you go telling yourself how rusty you are, check your speed by a code machine or W1AW to be sure. Then get to work on improving it. If you're a regular phone man and hardly ever work CW, then the best thing you can do is to put the mike away for a while and get out the key. The best (and most painless) way to up your code speed is to do some regular CW hamming. Nothing will get it up faster—and you'll be getting up to the speed you need to renew your ticket (if you fail the extra class exam).

I was away from ham radio for about four years at one time before I finally realized that to renew my ticket I was going to need some CW operating time. I rented some gear and put in a couple of good weeks on 40cw and got the needed time. But what surprised me was that I remembered the code at all. I not only had remembered it, but I was good for about 10 wpm when I started and was doing 15 to 18 when I quit. So don't start thinking pessimistic things about your code abilities. They are probably better than you think and with a little effort you can improve tremendously. After a couple of weeks of CW operation, check your speed again and do what's necessary to get it up to 20 wpm if you still need it. Practice is the key to it all.

Getting our code speed up to 20 wpm is probably the toughest requirement of the whole project. I personally feel that the 20 wpm requirement is dumb. That is a little too fast for comfort. Oh, I believe that the FCC exam should require a code capability, but why so fast? Is there really a reason for this other than trying to screen out as many persons as possible? If we could average the speeds of all CW stations on 40 meters some Saturday night, I bet it would fall in the 10 to 15 wpm range. That's not too fast or too slow. It's just comfortable and why shouldn't we be comfortable. This is our hobby isn't it and why should our hobby require us to be so uncomfortable? But we are stuck with this requirement so we ought to get used to the idea and start practicing.

Theory

The extra class exam is quite a bit tougher in the technical department than the general class, but with a little study we should be able to do it. I guess most guys will immediately rush out and buy a copy of the ARRL, CQ or Sam's license manual and will start memorizing it just like they did when they got their general class ticket. Well, believe it or not, this is not the quickest and easiest way that it seems to be. And if you do it this way, you are really cheating yourself. I'm not just saying this to offend some of you, and I'm not knocking license manuals. What I am trying to say is that too many of us get our tickets by memorizing, and the license manuals have made it too easy. It should not be this way but it is. The license manuals are written as a guide to the material covered on the FCC exams. They tell you what you can expect on the test and you really should have one. They are *NOT* written to teach you electronics, however, and this is what you need to do—learn electronics. Why? Let me give you a few reasons. First, by knowing electronics you will really understand the license manual questions. Most of them are basic theory and you will be able to answer from this basic knowledge alone. The more specialized questions, their answers and the explanations will be clear to you. All this means is that regardless of how they ask the question on the test, you will be able to answer it because you understand it and not because you memorized it. And your chances of passing the test will be much greater.

Second, a knowledge of electronics will make your hobby more enjoyable. You will understand how your equipment works, you will be more likely to fix your own gear when it breaks down instead of spending a lot of

1. Time constant is the time that it takes a capacitor to charge to 63.7% of the applied voltage through the accompanying resistor.

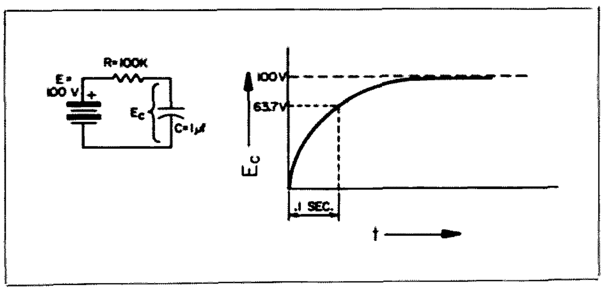


Fig. 1. Paragraph-sentence completion programmed text.

The time constant T in seconds is equal to the capacity multiplied by the resistance (T=RC), where R is in ohms and C is in farads. For example, with the values shown in the figure above, the time constant $T=RC=(10^5)(1\times10^{-6})=.1$ second. This means that the capacitor will charge up to 63.7% of 100 volts, 63.7 volts, in one-tenth of a second. (See graph) If the applied voltage in the circuit above was 25 volts, in one tenth of a second the capacitor would charge up to ________ volts.

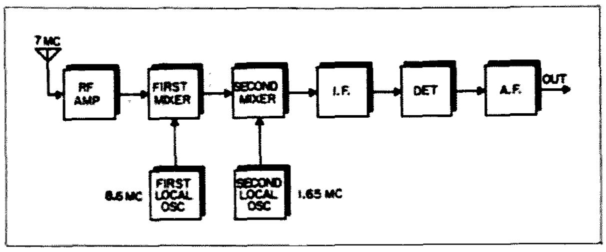
---

2. (15.925 volts) It takes approximately 5 time constants for the capacitor to charge up to full applied voltage. In the example of the previous frame, it would take $(.1)5 = .5$ seconds for the 1 µf capacitor to charge up to 100 volts. If the resistor value is 4 megohms, the capacitor is .05 µf and the applied voltage is 40 volts, it would take ________ seconds for the capacitor to charge to this value.

---

3. (1 second) Time constant also means the time it takes a capacitor to discharge to 36.3% of the value it was charged to. Etc.

1. Another form of the superhetrodyne receiver uses double conversion. In this type of receiver the incoming signal is converted to an intermediate frequency and then this IF signal is again converted to an even lower IF value. A block diagram of this kind of receiver is shown below.



The big advantage of double conversion receivers is the improved image rejection over conventional superhets. Also, selectivity can be improved since lower second IF's can be used.

Assuming that we are using difference frequency mixers, what is the second IF frequency shown?

3250 kc. . .go to frame 10
50 kc. . .go to frame 17
1600 kc. . .go to frame 26

---

10. Your answer, the second IF frequency is 3250 kc, is incorrect. The first IF is the difference between the oscillator frequency 8.6 mc and the incoming signal 7 mc. $8.6 - 7 = 1.6$ mc $= 1600$ kc. The second IF is the difference between the second local oscillator frequency 1650 kc and the first IF. You apparently determined the sum rather than the difference. While the second mixer will generate both the sum and the difference frequencies, we are interested in the difference only. Return to frame 1 and select the correct answer.

---

17. Your answer, 50 kc, is correct. The first IF is 8.6 mc $- 7$ mc $= 1.6$ mc $= 1600$ kc. The second IF is 1650 kc $- 1600$ kc $= 50$ kc.

The double conversion receiver is tuned like other superhets. The tuned circuits of the RF amplifier and local oscillator are gauged together and are adjusted simultaneously so they track. Now answer this question about double conversion receivers.

Which of the statements below is correct?

The second local oscillator is ganged and tuned simultaneously with the first local oscillator so that it tracks properly.
GO TO FRAME 8

The second local oscillator is usually tuned separately.
GO TO FRAME 11

The second local oscillator does not have to be tuned.
GO TO FRAME 13

---

26. Your answer, 1600 kc, is incorrect. This is the first IF derived by taking the difference between the local oscillator and the incoming signal in the mixer. $8.6 - 7 = 1.6$ mc $= 1600$ kc. Now determine the second IF the same way using 1600 kc as the input to the second mixer, then return to frame 1 and select the correct answer.

Fig. 2. Another form of programmed text.

money to have it fixed, and you may even get the urge to build that gadget you want—the one that's not made commercially. All these things are a little hard to appreciate if you're not already knowledgeable in electronics. Once you get that way though you will see what I mean. I got my general class ticket when I was 13 and I did it like many of you did—memorizing the license manual. Oh yes, I understood Ohm's law and had a fair idea how a tube works, but I really couldn't analyze circuits, fix my own gear or talk theory very well. Nevertheless, I had a good time with my commercial gear. But now I have a college degree, and I've been employed as an electronic engineer for several years. I really know theory, and I have learned to appreciate those things I mentioned earlier. It's a satisfying and secure feeling to know how my transceiver works and that I can probably fix it myself if it goes out. I've even designed and built an exotic electronic keyer that I wanted and couldn't buy.

Well, assuming that you're now sold on the idea of learning electronics, let's see how you can go about it. The first thing that probably comes into your mind is to rush in and get out your old Handbook and start reading. Well, basically there is nothing wrong with this, but it is probably the hardest and most boring way to do it. I don't have to tell you that reading theory out of a Handbook is not like reading a good story in Playboy or a James Bond book. After about an hour, if you last this long, you will be so bored that you may give up and chances are you won't be able to recall what you did read. What you need is a brief reading period followed by some practice in answering questions or working problems to test yourself. The handbook won't give you these and you won't get too far making up your own questions or problems. The license manuals help some here but they really do not have the practice material that you need. What you need is a planned and scheduled study and learning program. How do we get it? Well, if you are really gung-ho and don't mind spending a little money and putting in a little time, I recommend a correspondence course. There are several good schools offering home study courses in electronics with a communications slant. Many of them are designed to help a person get a commercial FCC license. Such courses are quite effective. They provide a planned curriculum and will give you plenty of practice problems and tests. They will be more than sufficient. The biggest problem is their cost and the time it takes to complete them. A good course costs somewhere in the $100 to $300 range and may take as long as a year or two to complete. This is the real Cadillac way to go and you certainly won't regret it. Besides, you will probably end up with a commercial FCC license as well as a nice diploma. If you're interested in this approach, drop a post card to one of the schools listed in **Table I.**

Another approach to the problem is a night school vocational course in electronics. Again cost and time are the main factors against it.

There is another way to accomplish your

objective. It is a rather new method and you'll probably enjoy it. It's effective, and it is truly a do-it-yourself technique. I recommend it highly. Have you ever heard of teaching machines or programmed instruction? These are relatively new ways to teach. The material to be learned is presented to you either by a machine or a special book in small, short doses and then you are immediately tested on this small bit of information by a question to answer or a problem to work. If you work the problem correctly, you are given another bit of information to read and then another test and so on. **Fig. 1** and **2** show examples of two different types of programmed instruction. In the first type, (**Fig. 1**) you read a short paragraph containing a fact or two and then you are tested by having to complete a statement involving the facts by filling in a blank. Each block of information is called a frame. In the next frame you are given the correct answer and then go on to some new material.

In the other type of programmed instruction, you are given a frame of information and a question or problem to answer. The question is usually the multiple choice type. If you answer correctly you are sent to a new frame of information. If you choose the wrong answer, you are sent to a special frame that tells you that you are wrong and explains why. It then sends you back to the previous frame to select the correct answer. **Fig. 2** is a typical example. As you will discover, this type of self instruction is infinitely better than reading your Handbook—it's more effective since you take an active part, and you won't get nearly as bored.

There are a good many of these programmed books on electronics available today and for a modest amount of cash you can pick up several of these. A list of titles and publishers is given in **Table II**. If you can't get these through your local bookstore, write the publisher directly. With some of these books and a promise to yourself to set aside an hour every night to work on it, you will learn electronics in no time and will be quite well prepared to study and understand the extra class license manual questions. The theory exam will be a snap.

The exam

Once you have gotten your code speed up and you are really hot on theory (don't forget to learn the FCC rules and regulations) run, don't walk, to your nearest FCC office. Take the exam while you are at your peak. The human mind won't retain all this unless you continually review or use this information, so use it while you've got it. Once you get the extra class ticket you can forget it all and go back to enjoying the non-technical aspect of your hobby if you want.

While you are boning up for the extra class license, you just might chip in a few bucks and buy a study guide for the FCC commercial licenses. (Your local library probably has a copy if you don't want to buy one.) These make good references and the study material on the 1st and 2nd class radiotelephone licenses is so close to being the same as that for the extra class license, you'll really be surprised. This commercial study guide will give you a different slant on the same material and will broaden your knowledge. Then when you go for the extra class exam, you might as well get your commerical license as well even though you don't need it. If you're going to impress your friends with a higher grade license, you might as well go all the way. Happy studying, and good luck! . . . W5TOM

Table I. Home study schools offering training in electronics with a communications or FCC license preparation slant.

National Radio Institute
3939 Wisconsin Avenue
Washington, D. C. 20016

National Schools
400 S. Figueroa Street
Los Angeles, Calif. 90037

Grantham School of Electronics
818 18th Street, N.W.
Washington, D. C. 20006

Cleveland Institute of Electronics
1776 East 17th Street
Cleveland, Ohio 44114

RCA Institutes Inc.
350 West 4th Street
"A Programmed Course in Basic Electronics"
New York, New York 10014

Table II. Programmed lesson material and books on electronics.

"A Programmed Course in Basic Electricity"

"A Programmed Course in Basic Transistors" by New York Institute of Technology, $6.95 each. Publisher: McGraw-Hill Book Company, 330 West 42nd Street, New York, New York.

"Basic Electronics: Autotext," A Programmed Course in Circuits by RCA Institutes Inc. $13.00. Publisher: Prentice-Hall Inc., Englewood Cliffs, New Jersey.

"Basic Electricity Electronics" (5 volumes) $19.95 (soft cover). Publisher: Howard W. Sams & Company Inc., 4300 West 62nd Street, Indianapolis, Indiana 46206.

"Applied Electricity" $12.50
"Introduction to Transistors" $9.50
"Basic Transistor Circuits" $9.50. Publisher: Basic Systems Inc., (Write directly) 880 Third Avenue, New York, New York.

International Educational Services, Inc., Scranton, Pennsylvania 18515. 16 lessons on basic electronic subjects: $4.95 each or all 16 for $65. Write direct for information.

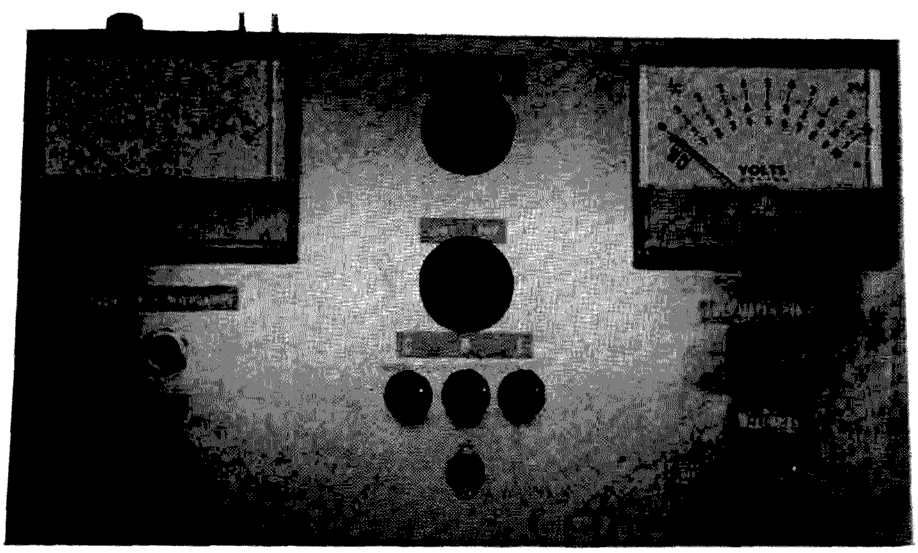
"Basic Electronics" Tutor Text, Publisher: Doubleday and Company, Inc., Garden City, New York.

Richard Palace K3LCV
4402 Clearfield Road
Wheaton, Maryland

Transistor Analyzer

Build this analyzer for checks on transistor input resistance, voltage feedback ratio, forward current gain and output admittance

Some of you will probably look at the title of this article and remark, "Here comes another transistor tester, but with a fancy name." Well this is not so, and if you really want to learn to design with transistors the professional way, read on. Good cheap transistors are readily available to the amateur, but locating their specifications is another story. Oh sure, you can look in one of the many parts catalogues available and come up with such things as current gain, polarity, breakdown voltage, plus a few other parameters and use these to design a few circuits by the seat of your pants. But chances are you don't know what you have. Do you know what the input and output resistances are, or what the current gain and voltage gains are, what is the bandpass at the 3 dB points, is the load matched to the output stage? Well this instrument won't tell you all this, but it will give you the necessary data on your bargain basement transistors so that you can calculate with good accuracy how it will behave in a circuit. This transistor analyzer will give you the "h" or hybrid parameters for the common emitter connection; these being "h_{11}" or "h_{ie}" the input



Front of the transistor analyzer. The left meter is for base current. It normally reads 0-1 mA, but the button below it can be pushed for a scale of 0-50 μA. The right meter is for collector current, and voltage between base and emitter or collector and emitter. These functions are selected by the switch between the meters.

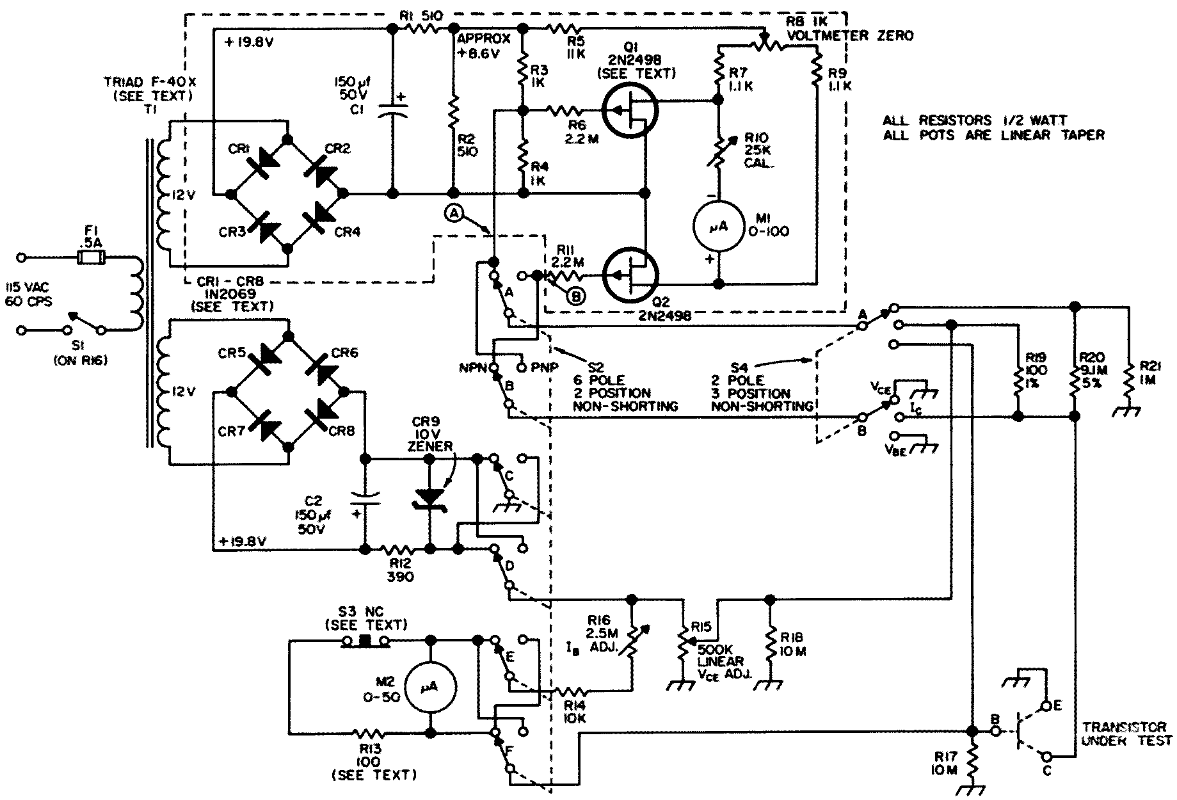
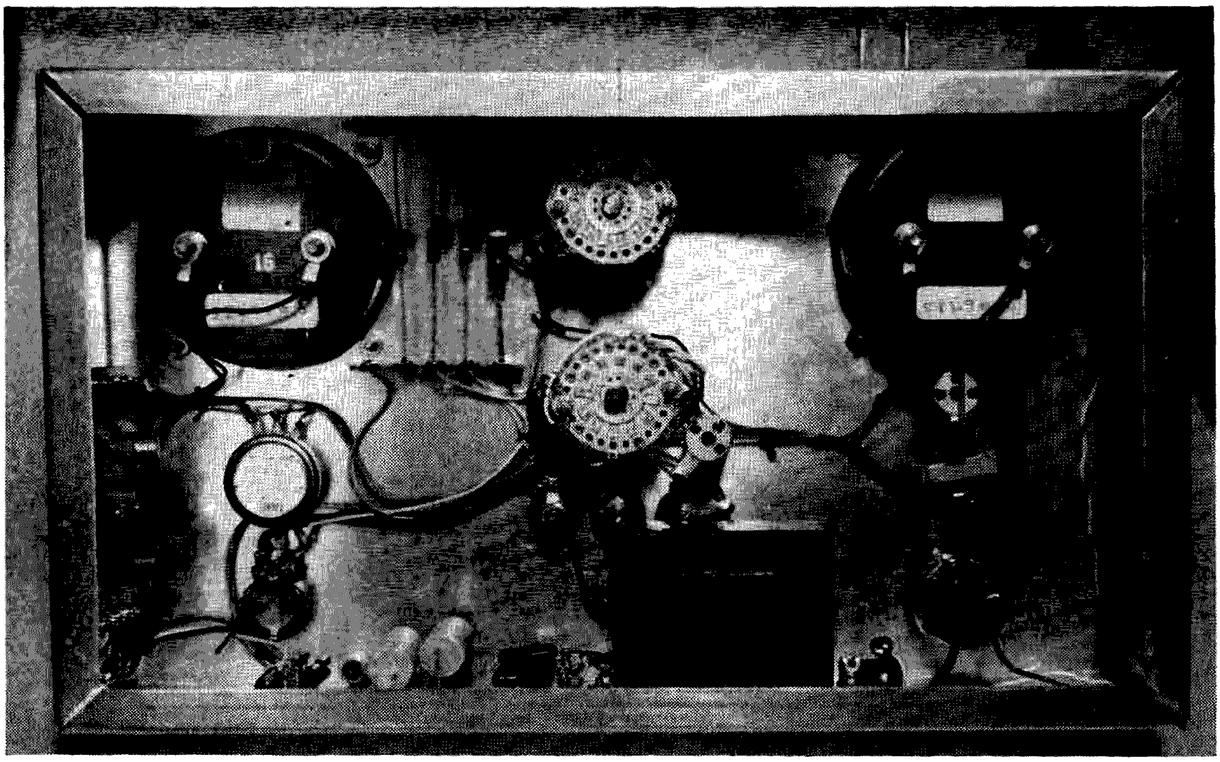


Fig. 1. Schematic of the transistor analyzer described in the text. It measures the hybrid parameters, h_{12}, h_{21}, h_{11}, and h_{22}, necessary for accurate checks on transistor capabilities.

resistance, "h_{12}" or "h_{re}" the voltage feedback ratio, "h_{21}" or "h_{fe}" the forward current gain, and "h_{22}" or "h_{oe}" the output admittance. These are the only "h" parameters needed, and by plugging these numbers into suitable equations, circuits can be designed and analyzed. More on this later; let's get to the hardware.

A look at the schematic diagram will reveal two separate power supplies. The power supply associated with CR1-CR4 and the remaining circuitry comprise a field effect voltmeter. This is the solid state equivalent of the vacuum tube voltmeter and has an input impedance of about 10 megohms. The high input impedance is necessary to avoid loading down the test transistor when measuring V_{BE}, the voltage from base to emitter. The basic sensitivity of the voltmeter is 1 volt full scale. In the V_{ce}, or volts collector to emitter position of S_4, the voltage divider consisting of R_{20} and R_{21} extends the range to 10 volts full scale. In the I_c, collector current and V_{BE}, volts to emitter position of S_4, full scale is 1 volt. For the I_c position the meter scale is calibrated 0 to 10 milliamperes since we are reading the voltage drop across a precision 100-ohm resistor. Potentiometer R_8 is the voltmeter zero and R_{10} is the calibration pot.

Power supply 2 serves to furnish the necessary voltages and currents to the transistor under test. R_{15} is the V_{ce} adjust and allows placing 0 to 10 volts approximately across the collector emitter of the test transistor and R_{16} is the base current adjust. Meter M_2 is used to monitor base current continuously during tests. This meter, a 50 microampere unit, is shunted by R_{13} to read a full scale of 1 milliampere. S_3, a normally closed push button switch, is used to remove R_{13} from the circuit so that a full scale reading of 50 microamperes can be obtained. This is a big help in reading small currents. Hindsight tells me that a 100 microampere unit would be more practical, since on some tests it doesn't take much to go off scale on a 50 microampere unit. However, mine is installed and calibrated and I will have to be content with it. A value of 100 ohms was a suitable shunt for my particular meter and others will no doubt have to determine the proper value for theirs. This is not hard, and the necessary information for doing so is available in any radio handbook. Switch S_2 is the polarity reversing switch and is shown schematically in the NPN position. Its function is to reverse the voltmeter, collector voltage supply, and base current supply so that both NPN and PNP devices can be tested. Q_1 and Q_2 are field effect devices man-



Rear view of K3LCV's transistor analyzer. The cabinet is open and uncrowded for easy construction.

ufactured by Texas Instruments. They are not cheap, and carry a price tag of about $12 each. If you buy the exact field effect, the voltmeter will work. I cannot say how other devices by other manufacturers will work in this circuit, but you can try. A little playing around on the bench with resistors R_5, R_7 and R_9 should get the circuit going with just about any field effect. If you feel you don't want to experiment with the circuit, then you can leave out the circuitry in the dashed block and bring points A and B out to test jacks. You can then connect any 10 megohm input impedance or better VTVM externally and realize a savings in parts and assembly time.

For construction I mounted all parts on a 7" x 12" x 3" chassis with meters and controls laid out as symmetrically as possible. Wiring is in no way critical as the voltages and currents are quite small. On my unit, two rather crude homemade printed circuit boards hold most of the small parts. For diodes CR1 through CR8 just about any cheap diode will do. Something around 100 PIV at about 50 milliamperes would be satisfactory, so check your junk box. T_1 is just a little special in that it has to undergo a little surgery to serve our purpose. Basically T_1 is a 24-volt center tapped filament transformer in which we will split the center tap and end up with two 12-volt windings. On the side that the three wires of the secondary come out, slit the outside protective paper vertically and peel both halves out of the way. The center tap connection is made up of two wires twisted together and spot welded to the single wire. Untwist these wires and solder leads to both of them. Slip some small tubing over the exposed joint, and glue the protective paper back in place with epoxy or what have you. Do this properly and all that will show is a thin scar line.

Calibration involves only the voltmeter and takes but a few minutes. Open the circuit at points A and B and connect a 10 megohm resistor between these points. Turn power on and zero the meter. Connect a 1-volt source across the 10 megohm resistor with plus at A and minus at B. Adjust R_{10} for a full scale reading on meter M_1. That's it; with the parts specified the voltmeter will read properly. If other field effects are used, first get the voltmeter working properly on the bench; then install and calibrate it.

Now that our analyzer is working properly, let's use it. If you built it as a Beta tester, it will give you two valuable pieces of information. It will give Beta, which everyone likes to know, and also the voltage needed on the base of the transistor to get a specified amount of collector current to flow. As an example, let's see what kind of data we can get from a transistor. Turn the analyzer on and set I_B and V_{ce} to minimum. Set the polarity switch to

NPN or PNP depending on the transistor being tested. Set the function switch S_4 to V_{ce} position and advance the V_{ce} adjust pot for 5 volts. Set function switch to I_c and advance I_B adjust for 1 mA of current. Beta is $\frac{\Delta I_c}{\Delta I_B} \,|\, V_c \,|$ which means: A small change in collector current (I_c) divided by a small change in base current (I_B) with the voltage on the collector held constant. Therefore, read base current for 1 mA and write it down. Now advance I_B adjust for 2 mA of collector current and again read the base current. Subtract the first base current reading from the second and divide the result into the change in collector current, which was 1 mA. This then is the Beta at about 1.5 mA. Always use the same terms when dividing; i.e., milliamperes into milliamperes, microamperes into microamperes, etc. Back off now on the I_B; adjust pot till I_c reads 1.5 mA. Switch to the V_{Be} position and read this voltage. You now know what voltage and current to apply to the base of your transistor to get 1.5 mA to flow. The above operations can be performed at various voltages and currents within the range of the instrument and are quite easy to do after a few practice tries.

The other 3 "h" parameters are h_{oe} or h_{22}, the output admittance which is $\frac{\Delta I_c}{\Delta V_c} \,|\, I_B \,|$, h_{ie} or h_{11} the input resistance, $\frac{\Delta V_B}{\Delta I_B} \,|\, V_c \,|$, and h_{re} or h_{12} the voltage feedback ratio $\frac{\Delta V_B}{\Delta V_c} \,|\, I_B \,|$.

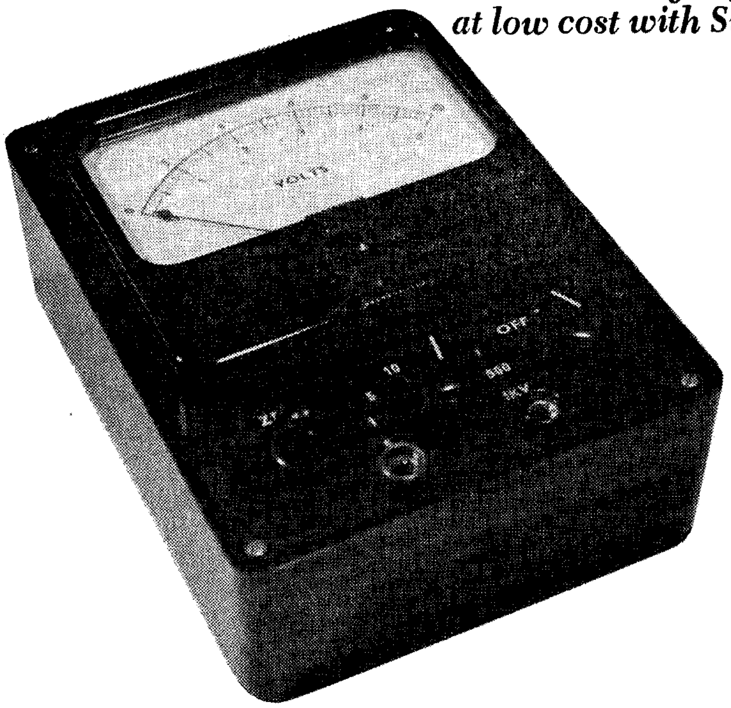
Calculate these the same as for Beta and remember to use volts and amperes in your division. Some representative values are $h_{fe} = 66$; $h_{oe} = 2 \times 10^{-5}$ mhos; $h_{ie} = 2000$ ohms; and $h_{re} = 1.2 \times 10^{-3}$.

If you have gone this far with me, let me explain that space does not permit me to give he equations needed to take advantage of his instrument. But let me hasten to recommend to you a fine book for those of you who want to know more. High school alegbra is all the math needed to understand this book. It is called: **Transistor Physics and Circuits,** y Robert L. Riddle and Marlin P. Ristenblatt and is published by Prentice-Hall. The authors do a good job taking you in nice easy steps from fundamentals through to actual circuit design.

Well, that's it; and I hope you can get as much out of this instrument as I have.

. . . K3LCV

Build this very high impedance (22 M) voltmeter at low cost with Siliconix field effect transistors.



Field Effec

Richard Palace K3LCU
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Here is a handy piece of test equipment for the ham shack. It features low power drain, instant warm-up, portability, and an extremely high input impedance. All this is accomplished by using field effect transistors which behave like screen grid vacuum tubes, but without the heater and high plate voltages normally associated with tubes.

This voltmeter will measure from .5 to 1000 volts with an input impedance of 22 megohms as compared to most commercial voltmeters which have input impedances of about 11

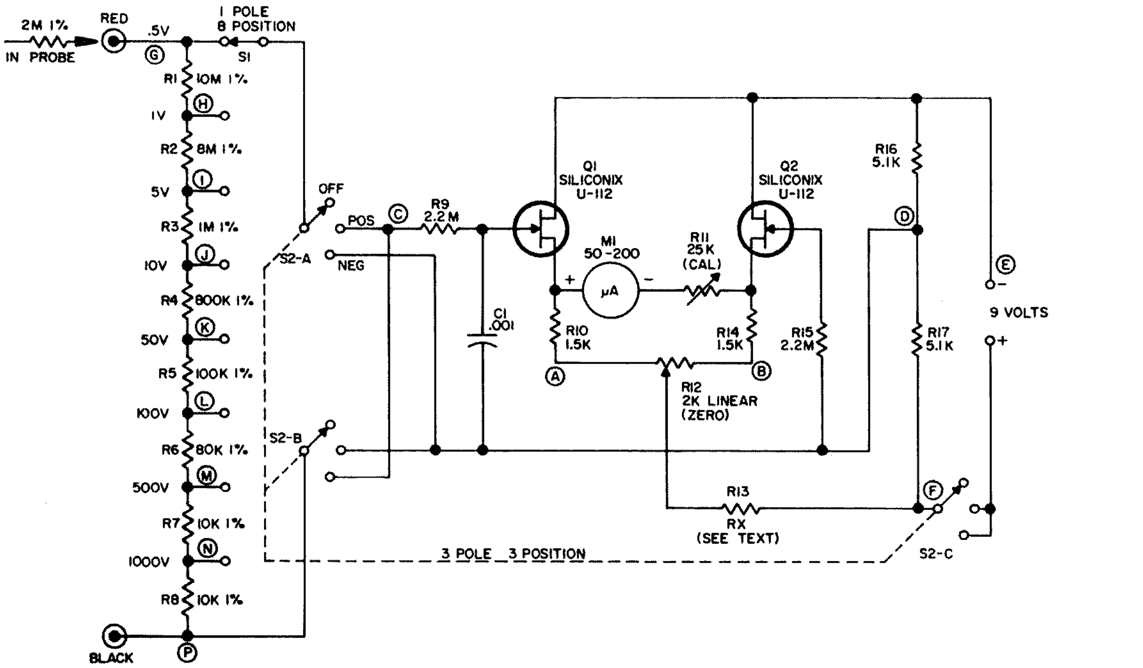
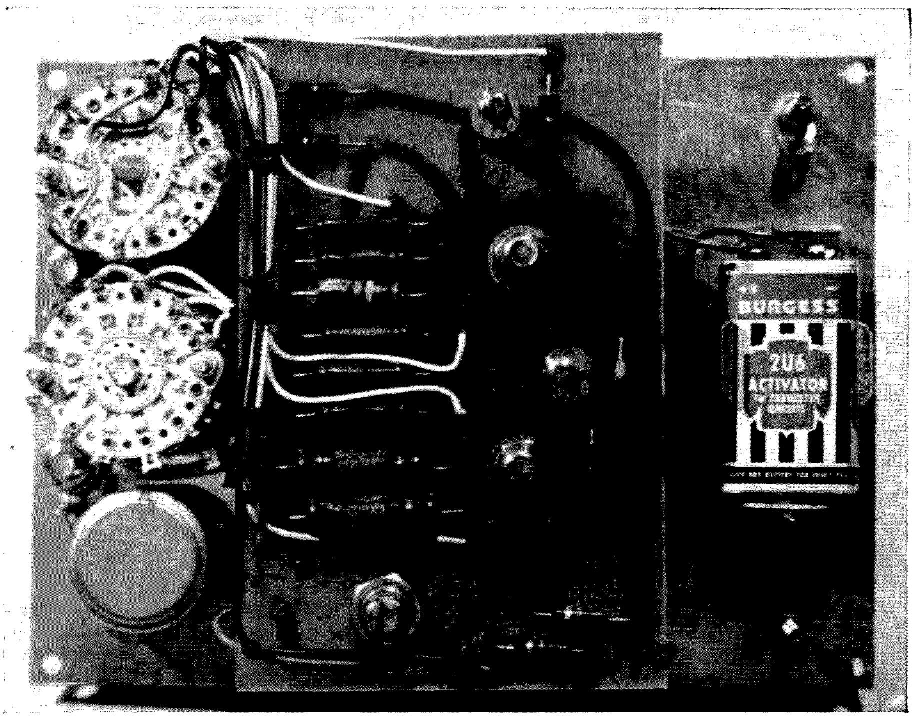


Fig. 1. Simple-to-build high impedance voltmeter using field effect transistors (FET's). Input impedance is 22 megohms. You can build the circuit on an etched circuit board using the plan in Fig. 2, or buy a low leakage, fiber glass board from the Harris Company, 56 E. Main St., Torrington, Connecticut, for only $2. Although these FET's are drawn as N-Channel devices the U-112 is a P-Channel field effect and the gate arrow should point in the other direction.

'oltmeter



Inside of the FET voltmeter showing the etched circuit board mounted on the meter terminals. The ceramic switches are recommended for low leakage since the input impedance is 22,000,000 ohms.

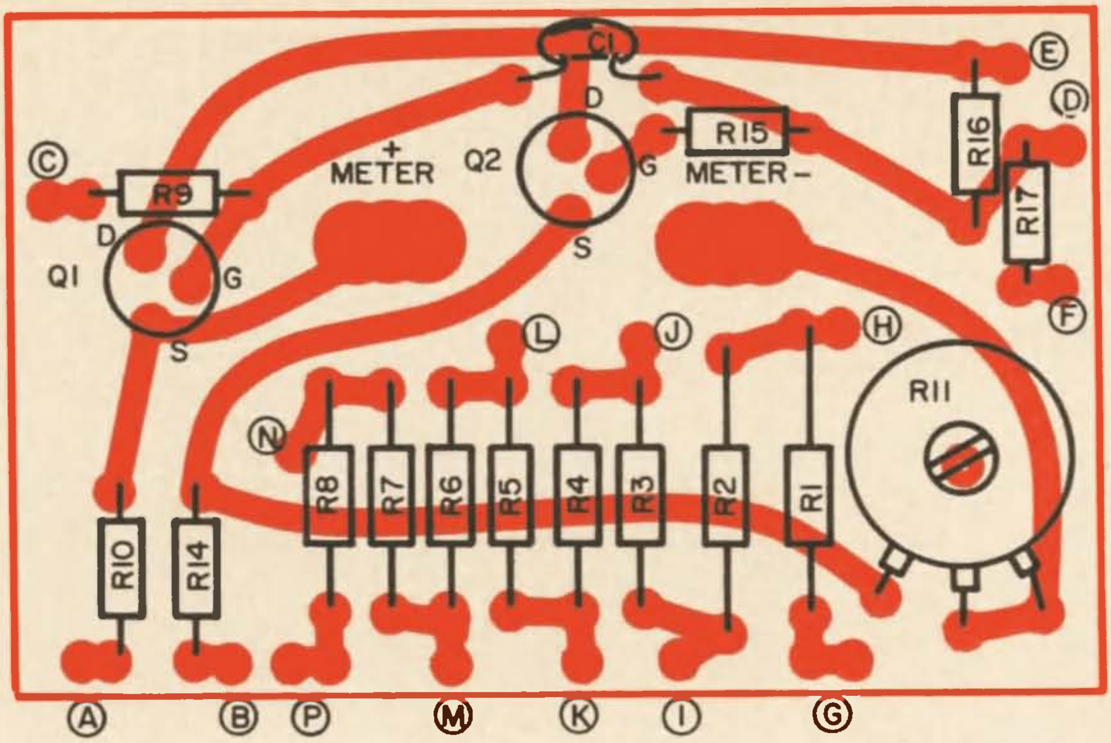
megohms. All this of course means that the FET voltmeter gives a truer reading because it loads the circuit under test less.

The circuit works as follows. FET Q2 is referenced to common or floating ground by R15. When the meter is zeroed by R12, the voltage drops across R10 and R14 are equal so no meter current flows. Effectively then, the gate of Q1 is also at ground, but biased at the correct operating point with respect to its source. Any signal introduced onto the gate of Q1 will change the operating point with respect to Q2 and the voltage drop will change across R10. Since a voltage difference now occurs across the meter a current proportional to the applied voltage will flow. Full scale deflection of the meter occurs with .5 volts input. The voltage divider string, R1 through R8 plus the 2 M. in the probe, is used so that full scale deflection occurs at several different voltages. R11 is the calibrate pot and serves to adjust the meter so that with .5 volts on the gate of Q1 the meter reads full scale. R13, although not needed on my unit, may be required with other FET's. It is used to set the linearity of the voltmeter so that .5 volts occurs at full scale and .25 volts at exactly half scale. R13's function is to slide the operating point up or down the FET's characteristic curve to utilize the most linear portion. Try a 10 k pot at R13 if you have difficulty finding a linear portion of the curve. When a linear scale is achieved measure the resistance required and permanently wire that value into the circuit. Interchanging Q1 and Q2 may help if they are not matched too closely. The meter M1 can be of any sensitivity from 50 µA to 200 µA. But bear in mind that the final accuracy of your voltmeter depends on the use of precision resistors in the voltage divider and also in the basic accuracy of the meter used. Buy the best meter that you can afford. I would also recommend using ceramic switches for SI and S2 to keep leakage paths to a minimum. All other resistors in the circuit may be half watt 5% carbon.

I won't go too deeply into construction as the photos are self explanatory. Use good construction techniques and if you use a printed board as I have—do by all means clean the board of excess resin after all the parts have been mounted. The resin comes off quite easily with alcohol (not the drinking type), and besides looking professional, it eliminates a source of leakage on your board.

A matched pair of Siliconix U-112 field effect transistors is available from Siliconix, Inc., 1140 West Evelyn Avenue, Sunnyvale, California 94086 for only $6.00. This is a tremendous bargain for these excellent FET's that normally sell for $16.50 in matched pairs.

After you've tried this FET voltmeter, you'll never want to use a vacuum tube voltmeter again. . . . K3LCU



BODY OF R11 MOUNTED ON FOIL SIDE

LETTERS IN CIRCLES CORRESPOND TO POINTS ON SCHEMATIC

Fig. 2. Full size layout of the etched circuit board for the FET voltmeter. Notice that this view is of the component side of the board, so if you make your own board, you'll want a mirror image of it for the copper pattern. Glass board is recommended for low leakage.

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An FET Audio Compressor

Build this simple compressor for higher average modulation from your transmitter. It uses two inexpensive field effect transistors for high input impedance.

Presented here is an audio compressor circuit which makes use of two field effect transistors in conjunction with two conventional (bipolar) type transistors. Simplified circuitry has been employed in order to keep costs at a minimum, but without sacrificing the necessary requirements for good speech compression.

This compressor has a compression range greater than 20 dB, and is capable of handling up to 300 mV input before distortion occurs due to overload. After exceeding the compression threshold, an output change of less than 1 dB will take place for each 6 dB change in input. The high (2.2 megohm) input impedance allows the use of either crystal, ceramic, or high impedance dynamic microphones without the use of additional transformers.

A brief review of compressor circuits

Since this is primarily a construction article and not a treatise on audio compressors no attempt will be made here to analyze the numerous compressor circuits now available and in popular use. However, a brief review of compressor circuits in general may be of some help in understanding why some compressors work better than others. It may also explain why judicious substitution of components will sometimes improve the circuit, but indiscriminate substitution often results in the compressor being relegated to the junk box.

Audio compressor circuits, whether vacuum tube or transistor, make use of a dc control voltage, (either positive or negative) to control either the amplifier gain, or to attenuate the input or output signal of the amplifier by applying the voltage to a control element.

Transistorized compressor circuits can usually be classified into two types. Each type can further be classified into several methods.

In one type the control voltage varies the forward transfer characteristics of the controlled stage by either reducing the emitter current, or by reducing the collector voltage. While these two methods require only simple circuitry, and only a few components, they are subject to some serious disadvantages. For instance, large input signals will result in distortion because the transistor is driven into a non-linear portion of its characteristic curve in an effort to reduce stage gain.

In the second type the circuitry is usually a little more complex, but the results are also usually more rewarding. Here again, any one of several methods may be used.

In this type of compressor the dynamic resistance of a diode or a transistor is varied by the control voltage and made to act as a variable resistor. The voltage-variable resistor may be placed across the amplifier input circuit to shunt a portion of the input signal to ground, or it may be placed across the output circuit to shunt the output voltage to ground. The voltage-variable resistance element may also be connected either in series or parallel with other circuit components carrying signal voltages to either attenuate the signal, or to "switch" the component in or out of the circuit to reduce the stage gain.

Since in this type of compressor the variable-resistance element is usually isolated from the

Bernard, former W2GRK and W2HPO, has been licensed since 1933. He's a research analyst with the Department of Defense in Washington.

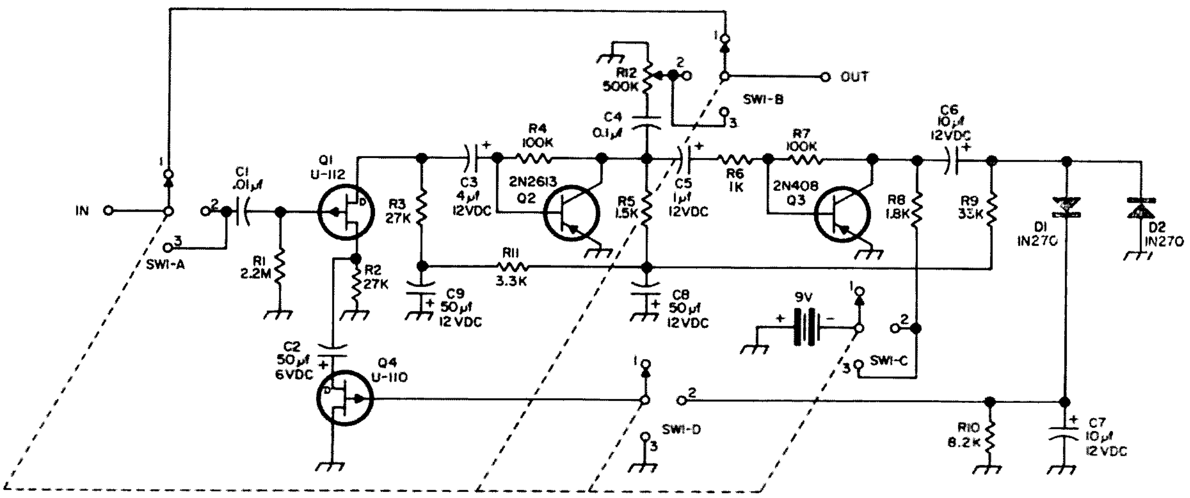


Fig. 1. Schematic of the FET compressor. There should be a dot indicating a connection at the cross-over between R8 and SW1-C.

dc circuits, the operating voltages and currents are not effected by the application of the control voltage. However, there is a possibility that with some methods noise produced by the control element may be introduced into the signal path.

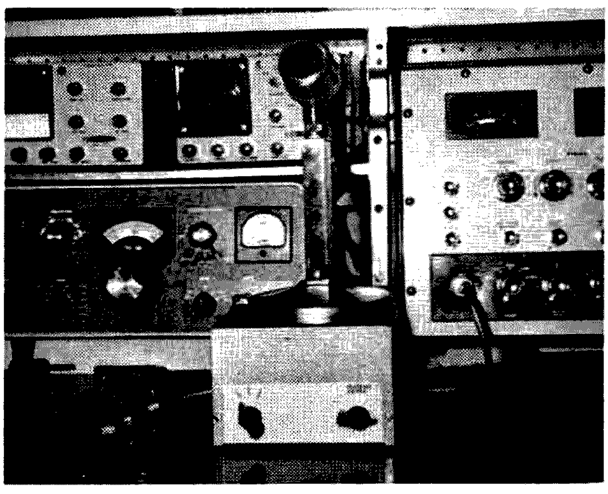
Of great importance to the proper operation of any compressor is the time constant circuit of the control voltage loop. Not only does this circuit determine the attack and release times of the controlled stage, but it must also filter the rectified ac voltage so that the control voltage will be reasonably free from ripple.

The attack and release times of some compressors may differ by as much as several hundred percent from the ideal. The ideal attack time should be about 1 msec or faster to prevent overshoot on steep wave front signals. In some circuits such a fast attack time could cause transient "thump" due to the inability of the amplifier to follow rapid changes in current or voltage.

Release times are usually made longer than the ideal time of 10 msec. If the release time is too fast the amplifier will recover before the lower audio frequencies have been filtered out. On the other hand, if the release time is too slow a weak syllable following a strong one will be compressed just as much as the strong one.

The compression range will depend on the circuit used and may vary from only a few dB to as much as 60 dB. The choice of compression range will depend upon the application of the compressor. A small amount of compression will limit audio peaks but will add little to the improvement in "talk power." Too much compression on the other hand will make the signal sound harsh. For speech compression a range of about 15 to 21 dB has been found to give the best results.

At this time perhaps one of the more popular misconceptions about audio compressors should be clarified. There seems to exist among many people the idea that the audio compressor will increase the peak power output of a transmitter. This is not quite true. Compression will improve the peak power output only if the low level audio stages of the transmitter have been deficient, or the microphone output level had been too low to supply sufficient audio to the transmitter, and then only because most compressors also act as audio preamplifiers. The primary purpose of the compressor however, is to improve the average power, or "talk power" of the transmitter by providing additional amplification to soft spoken syllables, and by reducing the amplification of loud syllables so that peak power



The FET compressor in use at K3VNR's shack.

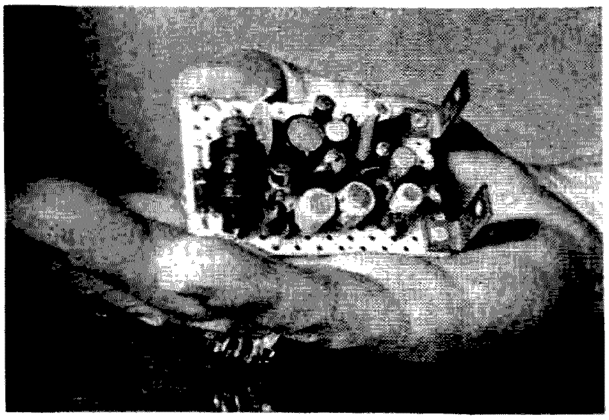
output is attained over a greater percentage of the time. This higher average output will show up in SSB in on-the-air reports that the receiver S-meter appears to "hang" close to the peak with only a slight variation between syllables. It will also show up on the transmitter plate current as a higher average reading.

Circuit description

The heart of the audio compressor described here consists of a pair of field effect transistors, the Siliconix U-110, and U-112, which were recently made available for the price of $2.75. Replacing these FET's with bipolar transistors would require sophisticated circuitry to perform the same functions, and at a considerably greater cost. By using the U-112 as the controlled amplifier stage it was possible to achieve a high impedance input, (2.2 megohms) without the use of an input transformer or an additional emitter follower stage. The U-110 in this case functions as the voltage-variable resistor to control the amplifier stage gain through the application of negative feedback to the source of the controlled stage. In addition to the 20 dB of compression previously mentioned, the result is a low noise, low distortion preamplifier with high gain.

No noise measurements were made, but scores of on-the-air tests proved to be very gratifying in this area. Also, although no extensive distortion measurements were conducted, cyclogram tests indicated negligible distortion.

The signal after being amplified by Q1 is further amplified by Q2, a 2N2613. This is a low noise transistor especially suitable for preamplifier circuits. The forward bias resistor R4 of this stage is connected between the base and collector in order to reduce the number of circuit components and still achieve some measure of stability.



This photo shows the small size of the compressor board (1½" x 2½"). The RF filter mentioned in the text is mounted at the left.

After amplification by Q2 the audio signal to the transmitter is taken off through the level control R12. Since even after compression the output voltage will still show a gain of 6 to 9 dB the level control is used to reduce the output to a suitable level for the transmitter.

A portion of the signal from Q2 is also amplified by Q3 to a higher level which is then rectified by D1 and D2 to become the dc control voltage. No attempt should be made to take the audio signal from the output of Q3 since the signal at this point is in the form of a square wave and will sound highly distorted.

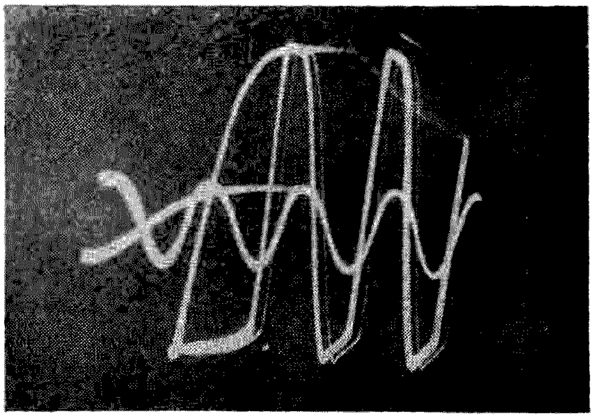
Notice that the forward bias resistor for this stage, like that of Q2, is also connected from collector to base. This means that a small amount of ac voltage will be fed back from the collector to the base and will also appear at R6. R6 will isolate this small amount of feedback so that it will not appear at the audio output as distortion. If the audio output is viewed on an oscilloscope, this distortion, if present, will appear as a bright spot at the baseline cross-over in mild cases, and in severe cases the baseline will actually show. Increasing the value of R6 will prevent this type of distortion but will also lower the available ac voltage at the base of Q3.

The output from Q3 is rectified by D1 and D2 and the resultant dc voltage is filtered by C7. This dc voltage is the control voltage which varies the drain-source resistance of Q4. Besides acting as the dc filter, C7 in combination with R10 sets the time constant of the control loop.

When a positive potential is applied to the gate of Q4 the drain-source resistance is increased, effectively switching off C2 which is the source bypass capacitor of Q1. When R2, the source resistor, is unbypassed an ac voltage drop is developed across the resistor and the gain of Q1 is reduced. With R2 in an unbypassed state negative feedback occurs and the percentage of harmonic distortion is reduced by an amount which is almost equal to the amount of compression.

When the amplifier gain is reduced the control voltage is also reduced and C7 discharges through R10. The bypass capacitor C2 is now "switched" back into the circuit and the amplifier recovers. Recovery time is determined by C7, R10 which has a time constant of approximately 82 msec.

In reality C2 is not switched in and out of the circuit by Q4 since Q4 has an irreducible amount of internal resistance between the source and the drain. However, since a switch is characterized by low resistance when it is closed, and high resistance when it is open, then for all practical purposes Q4 with its rise



This oscillogram was made by driving the amplifier to overload distortion, then switching in compression. Note the lack of distortion when compression is applied to the signal. What appears to be phase shift is a result of the method used to get this photo and is not caused by the compressor.

and fall in drain-source resistance is switching C2 on and off.

One of the advantages of this circuit is, that because Q4 is capacitor-coupled to the source of Q1 there is no change in bias current and therefore no distortion due to driving Q1 into the nonlinear region. Another advantage is that the sudden application of control voltage will not cause an objectionable transient thump.

The circuit does have a minor fault, but one which will have no effect on normal operations. As the input voltage is increased the control voltage will approach pinchoff, and "remoting" will take place .This is because Q4 will be operating in the "remote" region of the characteristic curve. In this region, as the positive potential to the gate is increased there will be no increase in the compression range since the FET does not follow square law behavior at low drain currents and there is no sharp cutoff. This, incidentally, may illustrate the difference between "pinchoff" as applied to the FET, and "cutoff" as applied to a triode vacuum tube when the grid bias is increased. This small fault should cause no trouble when the compressor is used with a microphone input since the voltage developed by the microphone will never reach a level where "remoting" can take place, and is only mentioned here as a point of interest.

Construction And Testing

No difficulties should be encountered in constructing this unit. With the exception of the switch and output level control, all components, including an RF filter not shown in the circuit diagram, were mounted on a piece of perf-board measuring 1½ x 2½ inches. An RF filter was included in the final construction as an added precaution against stray RF being picked up and rectified, but this filter may not be necessary in all cases.

Wherever possible the components were mounted in a vertical position in order to conserve space. With double-ended components, such as resistors, and some capacitors, the technique is to bend one lead back towards the body of the component so that both leads will face in the same direction, thus forming a single-ended component. The two leads are then placed in adjacent holes in the perf-board.

Although the unit is compact enough to be mounted in a small Minibox, one measuring 4 x 5 x 6 inches was used. This large size Minibox allows the controls to be mounted conveniently on the front panel without crowding, and also allows the use of a larger sized battery. Instead of chassis type of connectors, cable type connectors attached to short pieces of shielded mike cable were used. This eliminates the use of a patch-cord between the compressor and the transmitter, and permits easy changes to be made in the future in the event that a new transmitter might use a different type of mike connector.

The test procedure is quite simple. A VTVM, and oscilloscope (if available) is connected to the output. A 400 Hz audio signal is fed to the input. If a signal generator is not available a microphone picking up a beat note from a receiver will suffice.

The compressor switch is turned to position three and the audio input level is adjusted to give an output reading of 100 mV with the output level control turned full up. With the switch in this position no compression is being applied to the signal. Note the waveform and amplitude of the signal on the oscilloscope; the display should show a pure sine wave.

Without further adjustment of the input signal, turn the compressor switch to position two. With the switch in this position compression is now being applied to the signal. The output reading should drop to 18 mV for 15 dB of compression. The oscilloscope display should also indicate this drop in output, and waveform should remain a pure sine wave but lower in amplitude.

Switch the compressor back to position three and increase the input signal so that the output now reads 200 mV. This is an increase of 6 dB in output which also roughly corresponds to a 6 dB increase in input since at these signal levels the amplifier gain is quite linear. Again note the oscilloscope display.

Without changing the input signal switch the compressor to position two to apply compression. The output reading should now be about 20 mV indicating 20 dB of compression.

Except for a lower amplitude the oscilloscope pattern should remain the same. Note that although the input signal had been increased by about 6 db with no compression, under compression the output signal change was about 1 dB.

This completes the testing, but an interesting little experiment can be conducted here by carrying these tests to the point where "remoting" takes place. It is also interesting to see that when the input is increased to a point where overload distortion takes place with no compression, by switching in compression the overload distortion will disappear. This is because negative feedback is now applied and a new input level is set for overload distortion.

Operation

Because there is only one control to adjust, the output level control, operation is virtually self-explanatory.

With the compression switch in position one, speak into the mike and adjust the transmitter audio gain control for proper operation. Since the mike is feeding straight through to the transmitter the audio gain control should be at the usual setting.

Turn down the compressor output level control and turn the switch to position two. Speak into the mike and slowly turn up the output control. Proper setting for this control will be indicated on the transmitter when full modulation is reached. If VOX is used, and if it had been marginal before, back off a little on the transmitter audio gain control as the compressor output level control is advanced. A few minutes of adjusting should show the proper settings for the audio gain control and VOX controls of the transmitter, and the output level control of audio compressor.

Note that when the compressor is first turned on an initial transient surge will render the compressor momentarily inoperative, but the amplifier will recover rapidly. Also note that position three of SW1 is not used during operation.

Conclusion

Although a 9 volt battery supply was used in the design of this compressor, voltages ranging from 6 to 12 volts have been used successfully. An ac pack could be used providing it is well filtered. The power source could also come from the transmitter filament transformer by using a pair of diodes in a voltage doubler circuit, and a proper filter. Bear in mind though, that any additional leads brought into the Minibox could introduce ac hum, and stray RF pickup.

If compressor is to be operated directly from a 12 volt car battery in a mobile installation, all 12 volt capacitors should be changed to 15 volt units. Also observe proper ground polarity; since the circuit as shown in the diagram has a positive ground.

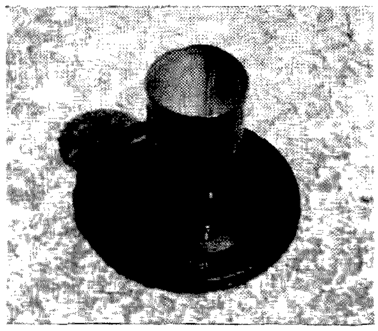
Only the U-110, and U-112 FET's were tried in this circuit. Undoubtedly with minor component changes other FET's will work just as well. In any case Q4 should have a low pinchoff.

The diodes D1, D2 have been specified as 1N274's, but other diodes, including the "dollar a dozen" variety, were tried with satisfactory results.

Resistor R9 sets the compression threshold. A higher resistance will lower the threshold. Replacing R9 with a combination fixed and variable resistor will allow the threshold to be adjusted.

Several other refinements, such as a meter to read compression, could be made, but the additional cost would defeat one of the primary aims, a low cost audio compressor.

. . . K3VNR



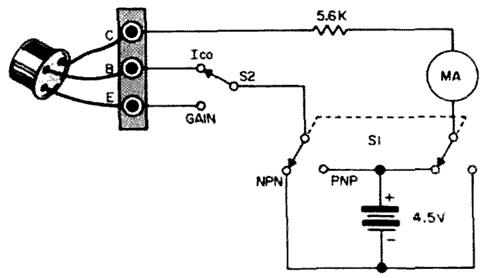
Tool Holder

This little gadget is very useful for holding those small tools for alignment, pencils, soldering aids, etc. The tray holds small items temporarily removed from equipment. You can see from the photo that the construction requires only an orange can and the lid from a coffee can. A coat of paint improves the appearance.

. . . Lou Bueke W3UGR

Simple Transistor Tester

Here is a simple transistor tester designed to check the leakage and gain of any low or medium power NPN or PNP transistor. The circuit is shown in **Fig. 1.** It can easily be built from junk box or surplus parts at low cost. A common multitester is used for the meter.

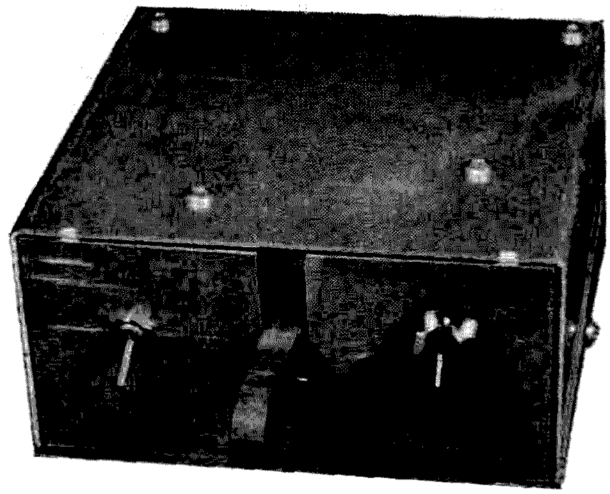


To check transistors for Ico (leakage), set switch S_2 to Ico and S_1 to PNP or NPN depending on the type of transistor. Insert the transistor in the socket, being careful not to short the leads. If the meter reads over 250 μa for transistors other than power transistors, the transistor is defective. Low power transistors should have very little leakage, 1-5 μa. Medium power ones have more, up to 10 μa.

If you don't know whether the transistor is PNP or NPN, use the lower setting as you switch from NPN to PNP. To check for gain, push S_2 to Gain. The meter reading should be 20 to 40 times the value of Ico as read before.

. . . Ralph Sergo K2PYE

George Daughters WB6AIG
1613 Notre Dame Drive
Mountain View, California 94040



The Kindly Keyer

This electronic keyer is similar in block diagram to the popular "Bugless Bug"[1] and uses approximately the same techniques to generate the signals. It is kind to the pocketbook and to the operator. It has a speed range of 1 wpm to a rate far exceeding 100 wpm!

It was developed in response to a question by K7UTF, "VT" Green, and uses the low-priced silicon epoxy transistors and micrologic elements now available from Fairchild. The total cost is on the order of $30.00 with all *new* parts if you have a machinist friend (or some dexterity) to provide a paddle.

George, former K9KDE, is a research assistant (BS, Illinois) at Palo Alto Medical Research Foundation. He enjoys home-brewing (his rig is all transistor-all home brew) and CW contests.

Operation

Moving the paddle to the "dit" position causes the saturating switch Q_2 to turn off (μL_{5B} is just an inverter), allowing the blocking oscillator Q_1 to run, providing a series of very short negative pulses to the pair of inverter amplifiers μL_{1A} and μL_{1B}. These produce a fast rise and fall time suitable for toggling the flip-flop, μL_2.[2] The output of the

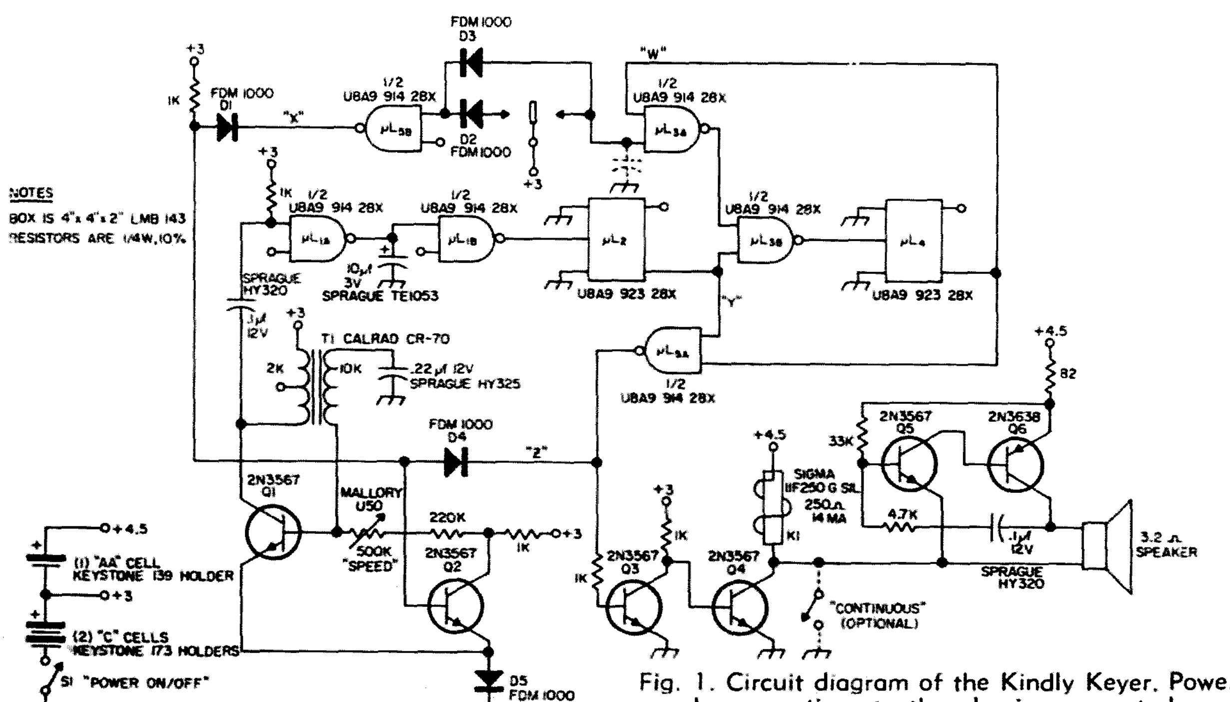


Fig. 1. Circuit diagram of the Kindly Keyer. Power supply connections to the µLogics are not shown. Eliminate dotted capacitor. Label connections to µL2 and µL4 S, T and C from the top. See Fig. 2.

flip-flop is inverted by μL_{5A} and fed to the inverter Q_3 and relay driver Q_4. Thus the relay (and the monitor—a version of G.E.'s "Transistor Manual" audio oscillator) are keyed at a rate which is ½ that of the blocking oscillator. (The flip-flop toggles only on negative going slopes.)

For dahs, all of the above happens, but the gate μL_{3B} allows the second flip-flop μL_4 to toggle also and the output of this flip-flop is combined with μL_2's output to make a dah.

To obtain self completion of a dit or dah, the output of μL_{5A} "Z" is used to keep the blocking oscillator going as long as a figure is in progress. The flip-flop μL_4 is assured of returning to the proper state by keeping the gate μL_{3B} open until a dah is completed.

Construction

The author's unit (**Fig. 1**) is built on a p c board as shown in **Fig. 3**. It can be easily "hard wired", of course. The parts layout shown is convenient, leaving room for the paddle mechanism. Micrologic wiring is a pleasure since all one does is hook wires where he wants the signal (or supply voltage) to go. To indicate the savings in parts here, the actual schematic of the flip-flop is shown in **Fig. 2**. The author's unit, with 3 dry cells and

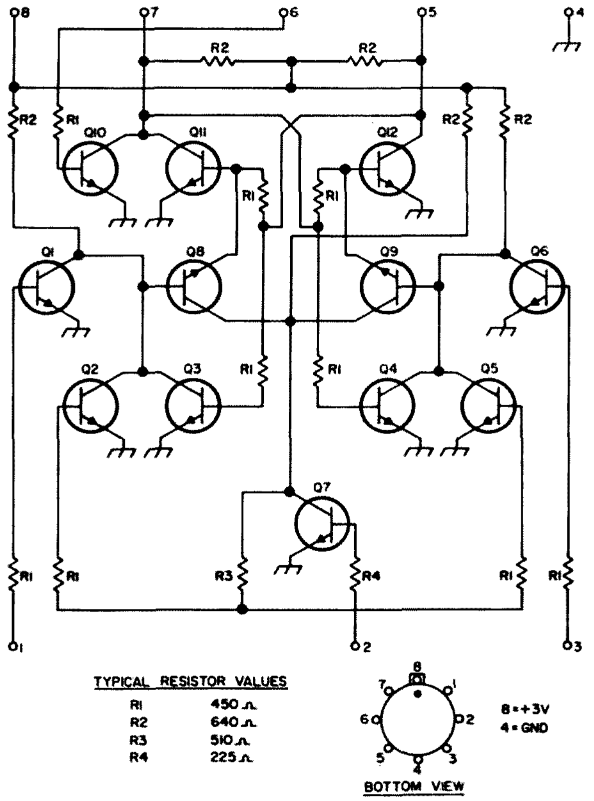
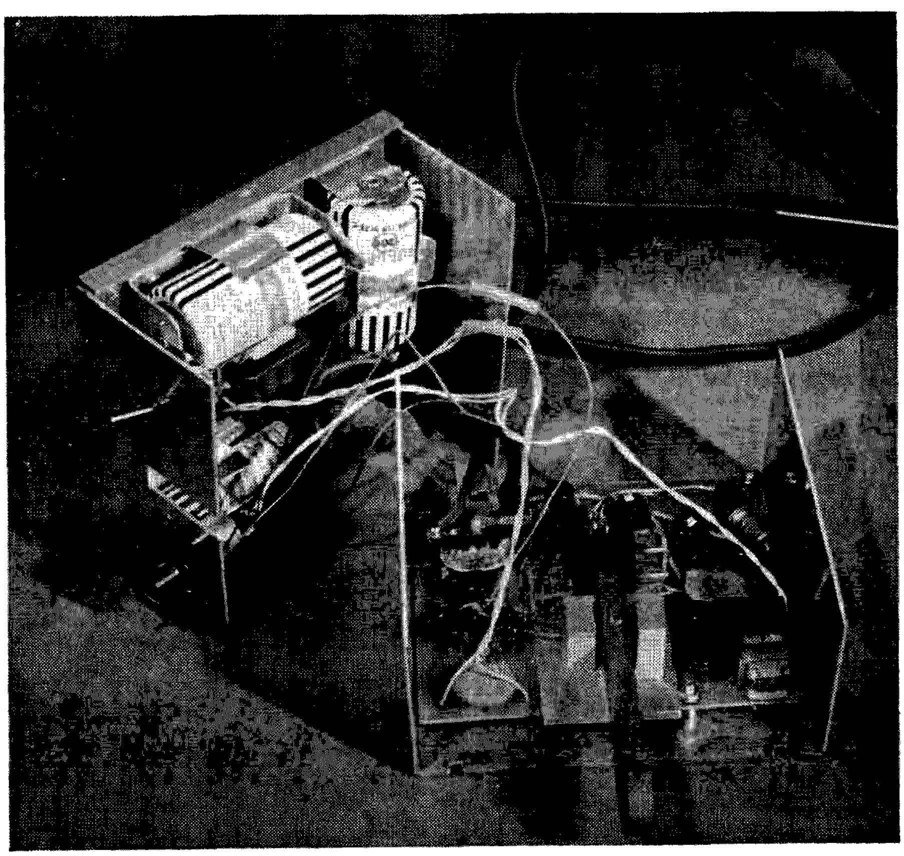


Fig. 2. Schematic and basing diagram of the fip-flop used in the Kindly Keyer. A look at this well illustrates the advantage of integrated circuits over individual components.



Here's the Kindly Keyer opened up to show the etched circuit board with the integrated circuits in place.

Fairchild epoxy encapsuled integrated circuits.

a 1-¾" speaker for the monitor, is built in a 2"x4"x4" box.

Conclusion

An electronic keyer whose electrical quality and operation are not exceeded by any on the market has been described. The little unit has only one disadvantage—it draws quite a bit of current. With the unit on but idling (since there are about 15 transistors saturated), it draws about 60 ma from the 3V supply. That is why "C" cells were chosen. During a dit or dah, this changes negligibly but all cells are then delivering relay and tone oscillator current, about 25 mA.

The size, weight, cost and operation of the unit are just right for carrying to the examiner's office for an extra class exam!

. . . WB6AIG

[1] "The Bugless Bug," Gilbert L. Boelke W2EUP QST; September, 1963.

[2] The flip-flop uses a charge storage principle for toggling, and is insensitive to D.C. (or slow) changes in level. See _L923 data sheet.

Transistors			
5—2N3567	at	$ .65	$3.25
1—2N3638 Don't use germanium; they are usually too leaky.		......	.46
Diodes			
5—FDM1000	at	.44	2.20
μLogic			
2—U8A9 923 28X JK Flip Flops	at	3.95	7.90
3—U8A9 914 28X Dual Two Input Gates	at	1.65	4.95
Capacitors			
2—.1 at 12V Sprague HY 320	at	.15	.30
1—.22 at 12V Sprague HY 325		......	.22
1—10μfd at 3V Sprague TE1053		......	.51
Resistors			
1—.5M Variable—Mallory U50		......	1.02
5—1K 1/4W 10%	at	.11	.88
1—4.7K 1/4W 10%			
1—33K 1/4W 10%			
1—220K 1/4W 10%			

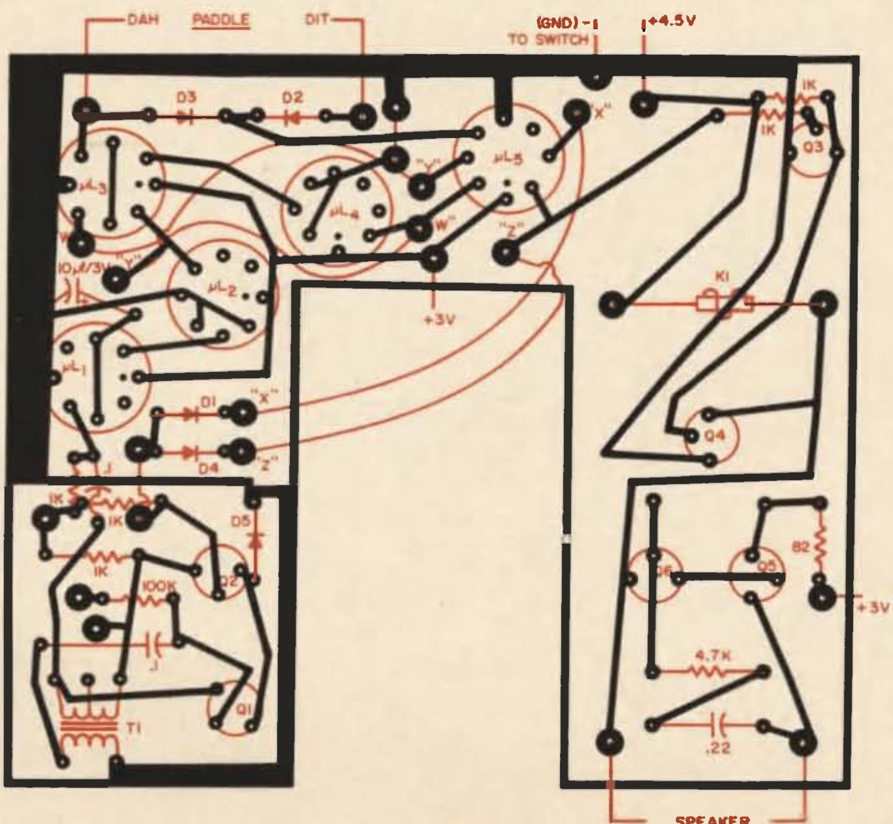


Fig. 3. Full size layout of the etched circuit board used. The components are on the opposite side as this is the copper side.

Don't throw away that silicon transistor with a shorted, open, or broken lead. Use it as a zener diode or varicap (varactor).

Save That Transistor!

E. R. Davisson K9VXL
83 Crestview Drive
Greenwood, Indiana

Need a low cost zener diode? Or how about a low cost voltage variable capacitor (varicap)? How many times have you had the desire to regulate that mobile converter, but didn't want (or couldn't) spend the 2 or 3 dollars additional for a zener diode? Or how about that tunable converter you wanted to remote tune by voltage, but, oh, the price of the varicaps? Well, stop! Remember that silicon transistor with the broken lead, or the one with the open collector, or was it the emitter lead that was open? Anyway, if you threw it away, you could have thrown away that low cost zener or varicap you needed.

First let's see what you could have done for a zener. By reverse-biasing the emitter-base junction of a silicon transistor, you have a very handy zener diode. Some silicon transistors even exhibit better zener diode characteristics than some of the diodes sold specifically as zeners.

Of course, the first obvious test is to determine what the zener voltage is for your specific transistor. Generally, most (there are always exceptions, of course) silicon NPN transistors will exhibit a zener action somewhere between 6 and 11 volts. (Pretty ideal for mobile regulators). **Fig. 1** shows the hookup for determining the zener voltage. A value of 470 ohms for R_s is sufficient to limit the current to a safe value while determining the zener voltage. Connect a variable power supply as shown and connect a VTVM from emitter to base. Notice that the collector is not connected and is not needed in this application. Now, slowly increase the input voltage while monitoring the voltage output on the VTVM. At a specific voltage input, the voltage out will stop increasing. Any further increase in the input voltage beyond this point will now cause only a very slight increase in output voltage. The voltage as read on the VTVM is your zener diode voltage. The next question asked is, "OK, but what range of current can I regulate?" A rule of thumb here is; divide the voltage obtained as the zener voltage into the free air dissipation rating of the transistor. For example, if the transistor zenered at 10 volts and is a 300 mW device, the 10 volts into 300 mW gives 30 mA. This would be a safe operating limit. However, tests indicate that this isn't necessarily the maximum limit, but it is unlikely that you would regulate a circuit drawing more.

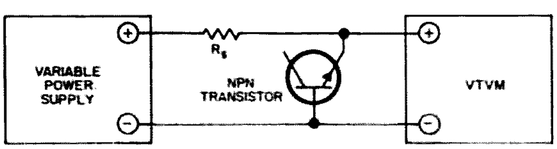


Fig. 1. Checking the zener voltage of diode junctions in NPN transistors. R_s can be about 470 ohms for these low voltage diodes. It limits current flow to keep from damaging the junction in the transistor.

OK, now you know what the zener voltage is and have an idea as to the amount of current you can regulate. Let's apply this to a more specific example. Suppose you want to regulate that mobile converter's oscillator stage. Let's say your transistor zeners at 10 volts. With 10 volts on your oscillator stage, it draws 3.75 mA. Since it's mobile, you will vary between the 12 volts from the battery to approximately 14.7 volts at maximum generator output. **Fig. 2** shows the hook-up. The only requirement is to determine the value of R_s so that the transistor (oops—I mean zener) will regulate properly with a variable input. To determine R_s, the following formula is used:

$$R_s = \frac{V_L - V_Z}{I_L + 0.1\ I_L}$$

where: V_L = lowest voltage input
V_Z = zener voltage
I_L = load current

Therefore, in the example, $V_L = 12$ volts, $V_Z = 10$ volts, and $I_L = 3.75$ mA. Using these values and solving for R_s gives a value of 485 ohms for the series resistor. A 470 ohm resistor would do quite nicely. As a check,

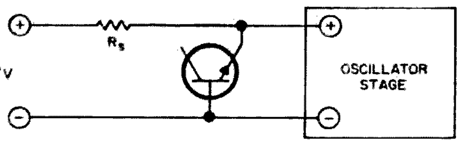


Fig. 2. Using a transistor as a zener diode to stabilize a transistor oscillator stage. Selection of R_s is discussed in the text.

let's determine what the maximum current will be through the zener. This will occur at the 14.7 volt input. At this level, R_s would have to drop 4.7 volts. This represents a total current through the 470 ohm resistor of 10 mA. The oscillator stage draws 3.75 mA. Therefore, only 6.25 mA is flowing through the zener, which is well within the dissipation rating of the device. In like respect, at the low voltage input, R_s drops only 2 volts which represents a total current of 4.25 mA. The zener draws only .5 mA in this case.

If your stage, which you desire to regulate, has a variable current requirement as well as a variable voltage input, use the following formula to determine the series resistor, R_s:

$$R_s = \frac{V_L - V_Z}{I_{Lmax} + 0.1\ I_{Lmax}}$$

where: I_{Lmax} = maximum load current

In like respect, if the input voltage is constant and the load current variable, use the same formula just given, with input voltage used in place of V_L.

These formulas are based on the premise that for conservative designs, the empirical factor of 10% of the maximum load current should be used for minimum zener current. In other words, the zener then is capable of regulating from this minimum current up to the value of maximum zener current as governed by the dissipation rating of the transistor. If your change in input is small, a figure of 20% may be used to better advantage for a little better regulating action.

Table 1 shows typical zener voltages meassured on various transistors. All but the 2N709 are available for under $1.00 as compared to zener diode prices ranging from several dollars and up. Notice that some (the exceptions) like the 2N94 have a very high zener which limits the usable current range. (Possibly low current B+ regulators?)

Pay particular attention to the Fairchild 2N3567. This device sells in the neighborhood of 60 cents and exhibits extremely good zener action. It also exhibits another characteristic to be covered next.

Now let's forget that emitter lead and use instead the collector lead in conjunction with the base lead. **Fig. 3A** shows a typical varicap tuned tank circuit and **3B** shows a NPN transistor connected for use as a varicap. C_1 in the figure isolates the varicap from DC. For this application, device dissipation is of little concern as only leakage current is flowing and will be quite insignificant. As with any series connection of capacitors, some consideration must be given to C_1. If this capacitor is quite large, compared to the varicap, then the tuning range of the tank circuit will be in direct proportion to the maximum change of the varicap's capacitance with applied voltage. If it is smaller than the varicap, then the change in frequency with the change in the varicap's capacitance with voltage will be small.

There are two means by which you can determine whether or not your silicon transistor will be suitable as a varicap. Some will have only a minor change in capacitance with voltage changes and others will have a greater change. The first method and by far the simplest is to refer to the data sheet for the transistor in question. If you're lucky, this capacitance change with voltage will be graphically plotted. The graph to look for is the output capacitance versus reverse bias voltage. This is listed on the data sheets as C_{ob} ($I_E = 0$).

The second method is to actually connect the transistor in question to a tank circuit such as that shown in **Fig. 3B**. Use a large by-pass such as a .001 for C_1 and a 100 K resistor for R_1. Place a suitable coil of known inductance across the transistor and capacitor as shown. Apply a DC voltage of 0.5 to 1 volt and then using a grid dip, find the resonant frequency of the tank circuit. Increase the supply voltage until further increases have little effect on the resonant frequency. Compute the value of the transistor's capacitance at the low voltage level and at the high voltage level. This gives you the range of capacity versus the voltage change required to produce this capacitance for the transistor in question.

Depending upon the application you have in mind, it's advisable to actually plot the

Transistor	Typical Zener Voltage
SE2001	6.1
2N706	6.2
2N3642	6.4
2N709	7.5
SE4002	9.8
SE6001	10.2
2N3567	10.2
2N94	50.0
2N233A	55.0
2N212	50.0

TABLE 1

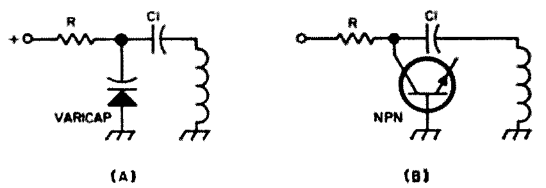


Fig. 3. Use of a varicap or transistor as a voltage variable capacitor in a tank circuit.

capacity versus the voltage. As with a true varicap, maximum capacitance occurs at a low voltage and minimum capacitance at the higher voltages. The rate of capacitance change is greater at the lower voltage changes and vice versa. For tuning applications, you would be concerned primarily with capacitance change obtainable for the range of voltage you have available. However, for an application such as producing FM, it is advisable to choose a section of the curve where linearity is achieved and bias the varicap to this value of voltage through a suitable divider. Then by applying an audio voltage to the varicap, a linear swing plus and minus may be achieved. Be sure that your bias point is sufficiently high so that the level of applied audio voltage doesn't overcome the bias on the varicap causing it to conduct.

Remember the Fairchild 2N3567 mentioned before for use as a zener? Well, here it is again. This little device exhibits excellent varicap characteristics. The capacitance and the capacitance change is ideal for a wide range of applications such as tuning, AFC, FM, etc. **Fig. 4** shows the typical C_{ob} of this device. As an example of the range possible with this particular device, consider a control voltage from 0.5 volts to 10 volts. This represents a capacitance of approximately 28 pF and 13 pF respectively. This is a capactance ratio of 2.15 to 1 which represents a possible frequency ratio of 1.46 to 1. In other words, you could tune from 40 MHz to 58.4 MHz or by proper choice of the coupling capacitor you could easily cover 50 to 54 MHz.

Incidentally, this 2N3567 can also be used, of all things, like a transistor. It is designed primarily for amplifier and switching applications. It exhibits a 40 volt collector to emitter voltage and 300 mW dissipation. Purchasing three of these devices at approximately $1.80 would enable you to build a fairly low cost zener regulated, voltage tuned, oscillator or RF stage.

As mentioned previously, some transistors only change several pF with voltage change, but don't overlook the possibility for FM transmitters where you only require 25 kHz or less swing where a small change in capacitance would be sufficient.

The applications given in this article are all for NPN silicon transistors since the most common silicons are NPN. There are a number of inexpensive PNP silicons now available and they can be used if you reverse the voltage shown.

So next time you start to pitch that NPN transistor with the open, or broken lead, stop and consider the other possible applications for it as a zener or varicap.

. . . K9VXL

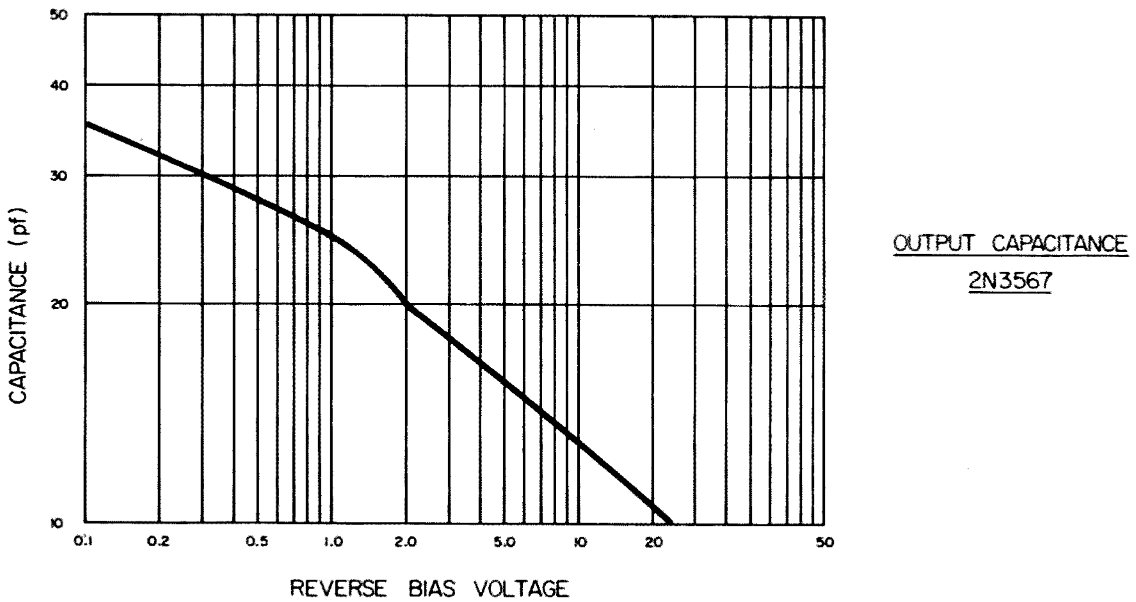


Fig. 4. Capacitance versus reverse bias voltage for the base collector junction of the Fairchild 2N3567 transistor.

Letters

Dear 73:

Re: The article on AGC by Jim Kyle on page 71-2 in the May 73. 4 ms rise time is too fast under conditions of impulse noise, a factor overlooked by the author. I have had to deliberately compromise it down to about 15 ms in order to copy best under static, otherwise the noise "loads up" the AGC so otherwise copyable signals are unhearable. Therefore I believe a slower attack time to be a must unless it can be varied. The distortion caused by the slower 15 ms rise time is quite small.

Will Henry K2AHB
RF Communications, Inc.
Rochester, N. Y.

Dear Paul,

After my article on "Choosing IF and Mixer Frequencies" appeared in the April issue of 73, it occured to me that some of the information in the article might be *misleading; from some of the correspondence* I have received, this has evidently occurred to some of your readers too. First of all, let me point out that **both** the local oscillator **and** incoming signal must be present to generate a birdie. In addition, because of the selective circuits at the front end of the converter, it must be tuned to this point in the band. If there is not a signal at *the* spurious *point or if the receiver is not tuned to* that point, no birdie. Therefore, before your readers scrap all of their converters on the basis of the parameters presented in the article, they should take a close look at their operating condition and locale. If there are not apt to be any signals at the spurious points and/or they are not interested in working that part of the band, then obviously any birdies that occur *from* time to time are of no consequence.

Jim Fisk, WA6BSO
San Jose, California

Dear 73:

Keep up the good work. Your magazine is getting better every issue.

Levi Mayes

Dear 73:

Here's my renewal. I was going to let it lapse. The magazine isn't too great anymore—not as good as it was the first year but none of the competition is much better.

W. K. McKellips WA6LGI/4
Albany, Georgia

Dear Paul:

I just received new prices on the FET's from Texas Instruments mentioned in my article in the May 73. The 2N3823 is still $12.90, but the TI534 has been reduced from $7.80 to $4.50.

Jack McKay WA5KLY/6
Stanford, California

Dear 73:

If you can't lick 'em, etc. . .

Suggest you change the name of your magazine forthwith, the better to reflect the hamdom of today and to get into the mainstream of ham lingo.

Surely it should be 73's Magazine, or better yet **Best 73's** Magazine.

Let's get with it. . . Is that a BIG 10-4 good buddy?

Best best wishes,
Ansel Gridley W4GJO
Sarasota, Fla.

Dear 73:

The American Morse code listed in the article by W2AAA in the May 73 is full of mistakes. "L" is one long dash. "M" is two dashes. The Ampersand is "ES," not four dots. The semicolon is "SI." Parentheses are designated "PN" for beginning and "PY" for ending parentheses.

D. A. Bunker W7ZB
Portland, Oregon

The errors weren't W2AAA's. The typesetter and proofreaders had fits with those letters. Sorry. Paul.

James Ashe W2DXH
Freeville, N. Y.

Lambda Lines

Here's the simple, cheap, fast approach to lecher lines.

Over the past few years, new kinds of commercial gear and military surplus have made it quite easy to generate VHF frequencies. But the problem of measuring the frequencies has not become any easier for amateurs short on calibrated instruments. Of course this means the newcomer to VHF! What can he do to find what ballpark a circuit is radiating in, if there are no accurate devices available? When this problem came up recently, a simple solution appeared quite by accident. It was so simple, in fact, that its simplicity must be the feature that has kept it out of the ham publications. Another first for 73!

The traditional solution to the rough frequency measurement problem is to make up a Lecher Wire system. There is some question about the value of one of these in the modern ham shack. Narrow-band crystal-controlled techniques guarantee frequency and stability once the multipliers are tuned properly. In the old modulated oscillator days things were not that stable . . . so why go to all that carpentry and construction work for what fairly well promises to be a use-it-once gadget? Particularly when a little reflection (pun intended!) may bring out a cheaper, faster and better arrangement?

Ham and commercial builders of VHF gear have been using tuned stubs for years to match impedances, tune out frequencies, tune in others, etc. Yet it seems to have occurred to very few workers indeed that it might be possible to cut stubs to length accurately enough to serve as frequency standards. Apparently this can be done, with an accuracy of about 5%! This compares very favorably indeed with the performance of lower-frequency grid dip meters and some signal generators. It's pretty good for a pencil and yardstick operation: the only other items required are some understanding of how it works and a piece of 300 ohm twin lead. Belden #8235 recommended. You can calibrate that new GDO for 432 at a cost of just a few cents!

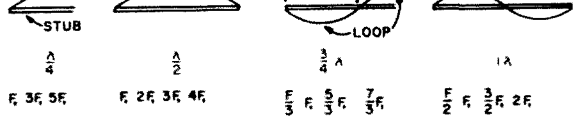


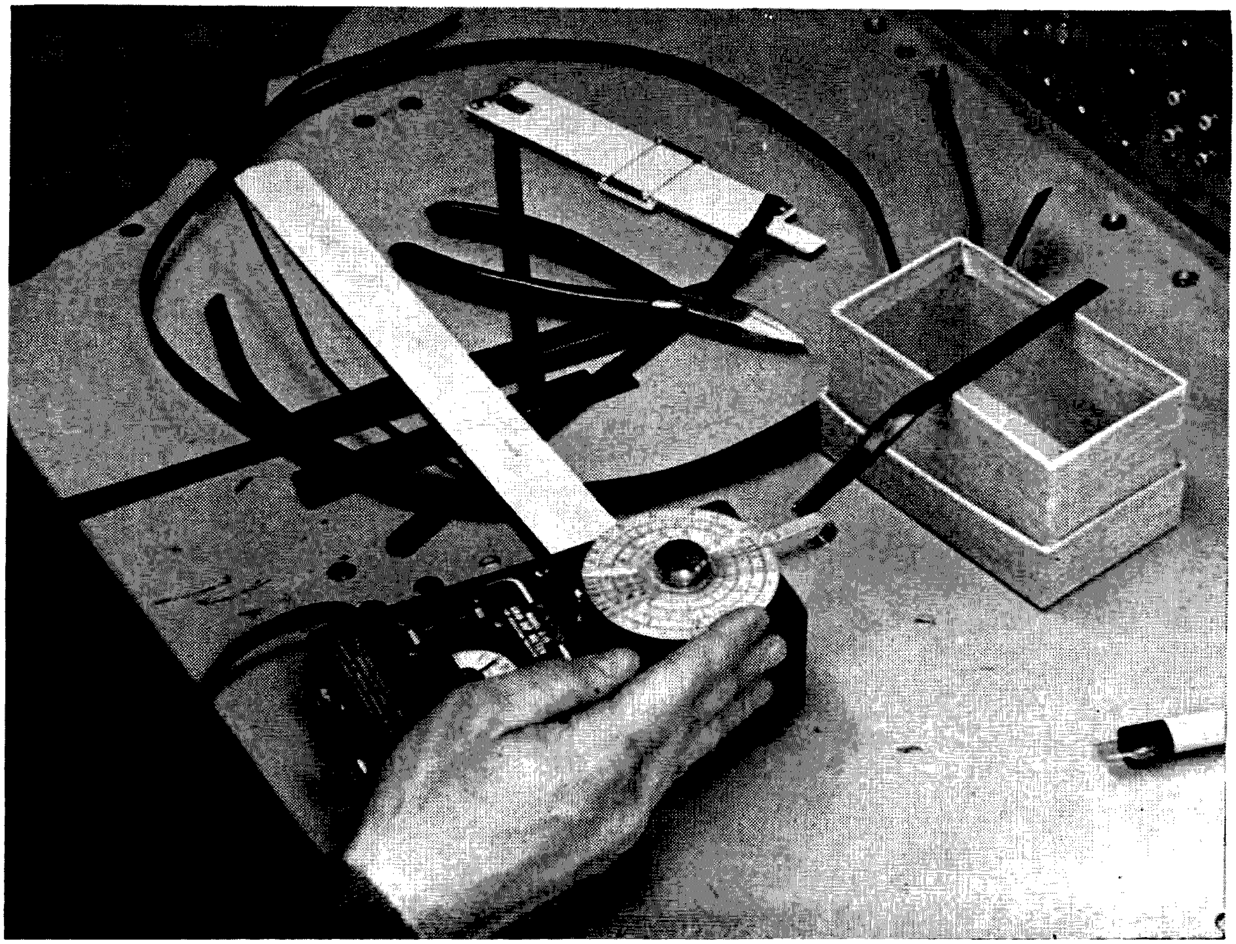
Fig. 1. Four kinds of tuned stubs, taking their fundamental resonances as the frequency producing the illustrated voltage distribution. This shows that none of them has a unique resonant frequency.

Theory

Many kinds of things show a property of tuning sharply to a certain frequency. This property is called resonance. We hear it when a struck piece of metal rings, and see it in the pendulum of an old grandfather clock. The grid dip meter shows a drop in grid current of an oscillator when a nearby resonant circuit steals energy from the oscillator. And it is the nearby resonant circuit that is the subject of this article.

The basic circuit is the quarter-wave stub. A little browsing around in the handbooks and earlier issues of 73 and other ham magazines will tell you lots about quarter wave stubs. The important practical points are that the stub resonates at certain frequencies, and that at these frequencies it can be dipped at its shorted end in the same way as any other resonant circuit.

But the term 'quarter-wave' has to be taken with a grain of salt. The tuned stub will be shorter than a free-space quarter wave, because the dielectric has a slowing-down effect on the rate at which the RF bounces end-to-end along it. Suppose you laid out a mile or so of twin-lead and transmitted a signal, at the same time sending off a reference signal by space wave. The reference signal would arrive at the other end first, in about 5.35 microseconds. The twin-lead signal would arrive a full microsecond later, about a 20% delay. Since this applies even to short lengths of twin-lead,



A quarter-wave lambda line for 220 MHz being used to check GDO calibration. This line shoula give a good indication of 660 MHz also.

the delay must be taken into account for accurate measurements. Also, there is a considerable difference in velocity factors between different brands and qualities of twin-lead.

Crystals are often used in overtone oscillators for generating stable VHF frequencies. The various modes of oscillation are pictured in the handbooks. Tuned lines will also show overtone resonances, and in the case of large uncertainty, it might just happen that reasonable errors could lead to a consistent but very wrong result. A halfwave line will resonate at a frequency f, and also at 2f, 3f, and so on. Note both odd and even multiples! All other resonant lines have a similar overtone resonance property. The problem is slightly aggravated by the convenience of using relatively long lines at the higher frequencies because they are easier to handle. The solution is to cut a pair of lines whose collections of resonant frequencies have only one resonance in common. The recommended lengths are a halfwave and a three-quarter wave line.

Fig. 1 shows four basic tuned lines. Just which resonance is an overtone and which is not depends somewhat on the application. The simplest way out of this problem in semantics is to say that the three-quarter wave line really doesn't have that resonance at f/3, ignore the quarter and fullwave lines, and stick to the remaining two for test work.

At 432 MHz a wave in free space is about 27.3 inches long. Suppose we are using Belden #8235 twin lead, which Belden says has a velocity factor or propagation constant of 0.77. The twinlead wavelength than is 27.3 times 0.77 or 21 inches. The halfwave stub must be 10.5 inches long, shorted on both ends; and the three-quarter wave stub 15.75 inches long, shorted at one end. These are convenient lengths, not too long to use on the workbench, nor so short that percentage accuracy in cutting becomes a big question.

Using the stubs

The commercially available grid dip meters are not noted for accuracy. It's commonly estimated that the scale calibration can be trusted to within about 20%. With some care, calibration points taken from twin-lead resonators appear to be good to about 5%. The first

Fig. 2. Some overtone resonances of a halfwave stub (shorted at both ends). F1, F2, F3 and F4 should be 1F, 2F, 3F, 4F.

precaution is accurate construction. Cut the strips slightly long, short one end of each, and cut the three-quarter wave line to length. Then go more carefully at the other end of the halfwave line, which must be shorted at both ends. It should not be too hard to get the correct lengths within one sixteenth inch.

When making frequency checks, the lines must be held off the workbench an inch or two. Use small boxes or pieces of cardboard. Probably the better part of a foot distance is in order if the workbench is of metal or has a copper surface. At two meters, a perceptible change in calibration can be detected if the line is laid out on a wood surface! It's very good practice to make up lines for two meters or lower, and practice dipping them. Some refinement of technique will certainly be required before a halfwave and a three-quarter wave line can be made to dip at the same point on a standard dip meter. Once the trick is mastered, it can be carried up to the higher frequencies.

The lines are dipped in the same way as any coil. Because they have a very high Q, there will be a tendency for the dip oscillator to pull, or to seem to give different readings when tuning down to frequency and tuning up to frequency. The remedy is less coupling: move the dip meter a little further away from the line and try again. Dip the stub at its shorted end!

But what was that trick for calibrating a dip oscillator, mentioned earlier? Can't make up a pair of lines for each frequency. No need to! That's simply the reliable way for finding the right ballpark. When you're there, you can set the lines aside, make up another three-quarter wave resonator cut for the lowest frequency, and after marking that point on the scale, trim the stub up to the next calibration frequency. Throw the remainder away when done calibrating.

The half-wave stub is also useful as a tuned coupler. Suppose you want to tune an oscillator to a particular frequency but have nothing to indicate at that frequency. Loosely couple the RF into one end of the half-wave stub, and take it out the other end with a hairpin loop, through a diode to a 50 μA meter. You will only get a reading at the resonant frequency of the half-wave stub. Simple!

. . . W2DXH

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Designing Transistor RF Power Amplifiers

This article contains information for designing transistor power amplifiers, including a 50 MHz final.

Transistors capable of delivering several watts at frequencies up to several hundred megahertz are readily available at nominal cost, and development of improved devices, in regard to power output and operating frequency, is advancing rapidly. Because of transsistor voltage and current limits, and the need for proper matching, the tube oriented designer must slightly revise his design procedures and take certain cautions he would not ordinarily consider if he was designing with tubes.

These new design procedures, together with some of the precautions and other design dissimilarities are discussed here in sufficient detail to permit most readers of 73 to reap the benefits of technological advances being made by the semiconductor industry in RF power devices.

Voltage-current relationships

The majority of transistor RF power amplifiers fall into the Class B (zero base bias) category because this class of operation provides a greater power gain. (Some may want to call zero base bias Class C because it does take a few tenths of a volt to start the transistor conducting.) However, Class C operation (reverse base bias) with its higher collector efficiency is also suitable especially when efficiency is of greater importance than power gain. Moreover, it is practical, under certain conditions, for example, where a greater power gain than Class B provides is needed to operate a transistor RF power amplifier with a slight forward bias.

However, you must use caution when biasing RF power transistors for Class A operation. Transistors designed for RF power amplifier service, at high frequencies, have a very small base width. Without going into the details of safe operating area, it is sufficient to establish that, this narrow base width precludes operating these devices in a dc biased Class A circuit at even a fraction of their power rating. In fact, if you try, the device will be instantly destroyed. Therefore, if you are planning on building a transistorized SSB rig, where some forward bias is needed for linearity, or if the greater power gain of Class A operation is needed, limit the bias current to the low millampere region.

A basic transistor RF power amplifier circuit is shown in **Fig. 1.** The base has no bias applied to it, therefore, the circuit is operating Class B. With no signal and no bias applied to the base, the circuit is setting at the static operating point. That is, the voltage between the collector and emitter is equal to the supply voltage (V_{CC}) as shown in **Fig. 2.** Since

Darrell Thorpe, former WØPKB, and W9NYI, is the editor of the Motorola Military Electronics Division Engineering Bulletin.

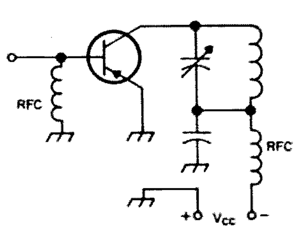

Fig. 1. Basic transistor RF power amplifier.

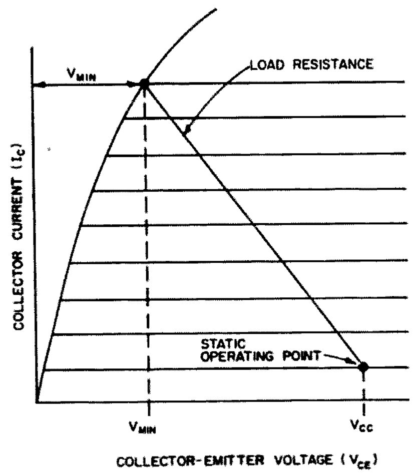

Fig. 2. Static operating point and load resistance curve.

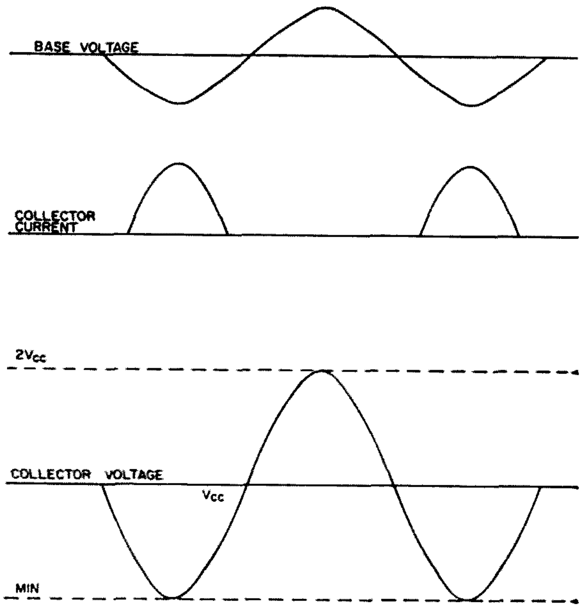

Fig. 3. Affect of base voltage on collector current and voltage.

the circuit illustrated employs a PNP transistor, the transistor conducts only when the voltage (applied drive signal) goes negative. Referring to **Fig. 3,** as the base voltage goes negative, there is a corresponding rise in collector current. Also, notice, from **Figs. 2** and **3,** that as collector current increases, the collector-emitter voltage drops to V_{min}.

Then, as the base voltage returns to zero, collector current goes to zero and collector voltage returns to V_{CC}. However, due to flywheel effect of the tank circuit, the collector voltage returns to V_{CC}. However, due to flywheel effect of the tank circuit, the collector voltage continues to increase until it reaches approximately $2V_{CC}$. The cycle then repeats.

Breakdown voltage and supply voltages

In vacuum tube circuits, breakdown voltage between the plate and other elements is seldom a consideration since it usually is much greater than the usual supply voltage. However, present day transistors are not so fortunate. Therefore, the breakdown voltage of the transistor must be considered when selecting devices and supply voltages.

As previously discussed, for an unmodulated transistor RF power amplifier, the collector voltage swings from V_{min} to approximately twice the source voltage. Therefore, the transistor must be able to withstand the peak-to-peak voltage which is $2V_{CC}-V_{min}$. Since V_{min} is usually only a few tenths of a volt, it can be neglected and the peak voltage can be considered as $2V_{CC}$.

Since the common-emitter configuration produces higher gain than a common-base configuration, the breakdown voltage of the transistor being considered will usually be BV_{CES}. Quite often BV_{CES} and BV_{CBO} are the same value. If the peak voltage happens to slightly exceed the breakdown voltage, the transistor will not be damaged provided the current and time duration are limited, but efficiency and gain will drop.

Thus, from the preceding discussion, it should be clear that a transistor should be selected with a BV_{CES} equal to or greater than $2V_{CC}$ or if this is not practical, V_{CC} should be set equal to or less than $BV_{CES}/2$.

For an AM power amplifier, these conditions must be modified to account for the increased peak-to-peak voltages which result from the modulating voltages. **Fig. 4** illustrates unmodulated and modulated carriers. The m on the modulated carrier represents the modulation index (m = 1 for 100% modulation). From **Fig. 4B,** for a modulated transmitter, the transistor must have a voltage rating of

$$BV_{CES} \geqq 2V_{CC}(1+m) \qquad (1)$$

or

$$V_{CC} \leqq \frac{BV_{CES}}{2(1+m)}.$$

Since m = 1 for 100% modulation,

$$V_{CC} \leqq \frac{BV_{CES}}{4}. \qquad (2)$$

Therefore, for CW or FM operation, where m = 0, the maximum collector voltage is approximately one-half the breakdown voltage, and for the final stage in an AM transmitter (m = 1) the maximum collector voltage must not exceed one-quarter of the breakdown voltage. Effects of slight clipping caused by breakdown on the upward modulation and saturation voltage on the downward modulation may generally be neglected.

Determining the optimum load resistance

In a transmitter, it is generally desirable to obtain a certain power output or the maximum power that a transistor is capable of delivering. Since the collector supply voltage is often limited either by breakdown voltage or the source i.e.; 6 or 12 volts in the case of mobile transmitters, the only variable is the effective load resistance at the collector.

To get a better understanding of how the load resistance (R_C) influences the maximum power output, it is necessary to examine the properties of an amplitude modulated signal

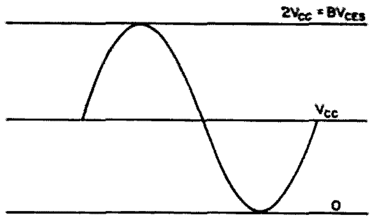

Fig. 4A. Unmodulated carrier.

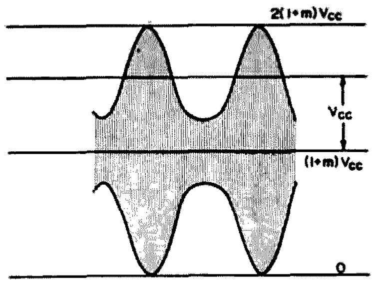

Fig. 4B. Modulated carrier.

more closely. The equations developed will easily reduce to the CW or FM case. **Fig. 5** illustrates the output at the collector of an AM final stage. The voltage is given by the expression

$$e_c = E_c\,(1 + m \sin \omega_m t)\,(\sin \omega_c t), \qquad (3)$$

where

e_c = instantaneous carrier voltage
E_c = unmodulated carrier amplitude
$\omega_m = 2\pi$ (frequency of modulating signal)
$\omega_c = 2\pi$ (frequency of carrier signal)
t = time, and
m = modulation index = E_m/E_c, where E_m = peak modulation voltage and E_c = peak unmodulated carrier voltage.

The peak voltage, E_p, occurs at the crest of the sine waves and is easily determined to be

$$E_p = E_c\,(1 + m) \qquad (4)$$

Using the standard ohms law equations, the peak power (P_p) is given by

$$P_p = \frac{E_p{}^2}{R_C}. \qquad (5)$$

Substituting Equation 4 into Equation 5 we have

$$P_p = \frac{E_c{}^2\,(1 + m)^2}{R_C}. \qquad (6)$$

By inspection of Equation 6 it is seen that the *peak* unmodulated (P_u) power (m = 0) is

$$P_u = \frac{E_c{}^2}{R_C}. \qquad (7)$$

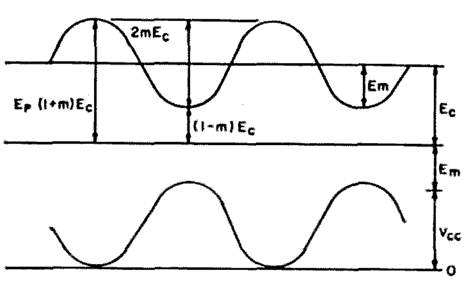

Fig. 5. Carrier with sine wave amplitude modulation.

and with modulation, the peak modulated power (P_m) is

$$P_m = P_u\,(1 + m)^2. \qquad (8)$$

Note, from Equation 8, that for a 100% modulated carrier (m = 1) that the peak modulated power is four times the unmodulated power. Thus, most of the power of an AM transmitter is contained within audio sidebands instead of the carrier. For this reason, when maximum talk range is desired from an AM transmitter, it should be designed and tuned so as to produce maximum demodulated audio signal with minimum distortion.

Getting back to determining the optimum load resistance for a desired power output, Equation 7 can be written

$$R_C = \frac{V_{CC}{}^2}{2P_u}. \qquad (9)$$

Where R_C is collector load resistance
V_{CC} is substituted for E_c
P_u is unmodulated power output

the factor 2 in Equation 9 comes from the conversion of peak power to rms power. R_C for a modulated transmitter is obtained by substituting Equation 8 into 9 which becomes

$$R_C = \frac{V_{CC}{}^2\left(1 + \frac{m^2}{2}\right)}{2P_u} \qquad (10)$$

Table I

	Max DC Supply Voltage (V_{CC})	Max Load Resistance (R_C)	Peak Power
AM (100% mod)	$\frac{BV_{CES}}{4}$	$\frac{3V_{CC}{}^2}{4P_u}$	$8P_u$
FM/CW	$\frac{BV_{CES}}{2}$	$\frac{V_{CC}{}^2}{2P_u}$	$2P_u$

Note: The simplification of the equations for the modulated transmitter is arrived at by letting m = 1 which is the case for 100% modulation.

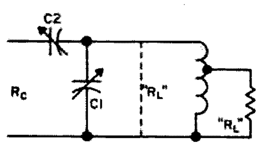

Fig. 6. One method of matching the load to the collector circuit.

From Equation 9 or 10, *the maximum collector load resistance that can be used for a given output can be calculated.*

A summary of voltage and load resistance relations is given in **Table I.**

CW and modulated power output capabilities

At VHF, the factors which limit power output, in most cases, are other than device power dissipation. Usually, high frequency transistors are peak voltage or peak current limited.

The voltage limits have already been discussed; however, a few words about current limits are needed to aid in understanding why transistor circuits behave as they do.

A transistor can be compared to an emission limited tube. That is, the amount of peak instantaneous current available is determined by the transistor structure, and no reserve or space charge effect exists. If a transistor is operated with maximum allowable collector supply voltage and the drive is increased until there is no further increase in output the maximum peak current has been reached. This condition is very seldom encountered in a tube, because the power dissipation limit of the tube is usually reached first.

The peak voltage and current limits are important factors for amplitude modulated transmitters because a device which is already operating at its collector supply voltage and current limits can not be upmodulated from that power level. As discussed earlier, for collector modulation, the supply voltage must be limited to one-fourth of the maximum transistor voltage rating to prevent breakdown, and since the peak current must double in addition to the voltage, a carrier level of one-fourth maximum power output must be maintained if 100 percent up-modulation is desired.

And, while we are on the subject of modulation, it is worthwhile to mention that feedthrough capacitance in transistors will allow a residual carrier to be passed from the driver through the final even if the down-modulating audio has reduced the collector-to-emitter voltage to zero. Hence, some modulation of the driver is needed to achieve good down-modulation of the final. Also, modulation of the driver will aid in achieving the higher peak current required by the final on up-modulation.

Design example

Up to this point, we have not considered matching networks to transform the actual load impedance, usually a 50-ohm or 300-ohm antenna, to the load the transistor needs to see so that the specified power output can be achieved. **Fig. 6** shows one method of coupling the collector circuit to the load. There are many other types of matching networks that can be used including the pi and L networks. If you desire to use one of these networks refer to one of the radio handbooks for equations to calculate component values. The matching circuit shown uses a parallel tuned circuit to couple the load to the collector circuit. The collector of the transistor is tapped down on the tank coil. Capacitor C_1 provides tuning for the fundamental frequency and C_2 matches R_C to the tank circuit.

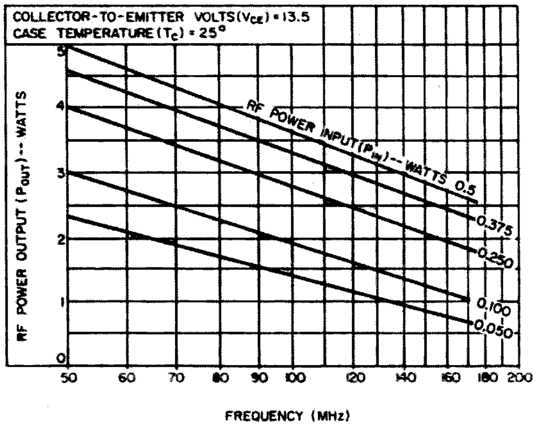

Fig. 7. Characteristic curves for the 2N3553 at 28 volt emitter to collector voltage.

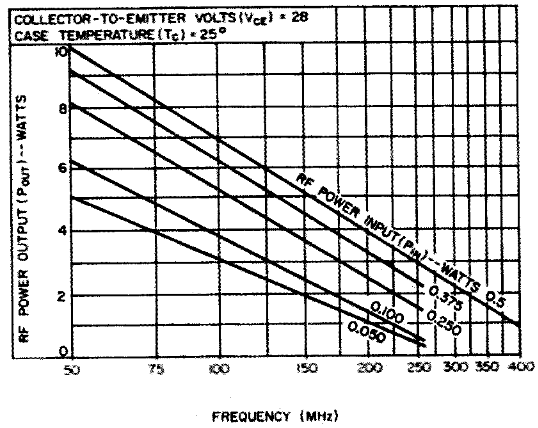

Fig. 8. Characteristic curves for the 2N3553 for 15 volt emitter to collector voltage.

Let's assume we are designing a 50 MHz final using the RCA, 2N3553 transistor. Characteristic curves on the data sheet (see **Figs. 7** and **8**) show that this device can typically provide 5 watts (CW) from a 13.5-volt source at 50 MHz and 10 watts with a 28-volt source. Specified BV_{CES} is 65 volts which is sufficient for either CW or AM from a 13.5-volt source (use the equations and check for yourself). Therefore, let's design for a peak modulated power output of 10 watts which corresponds to a 2.5-watt unmodulated carrier.

The maximum load resistance is (see Table I)

$$R_C = \frac{3V_{CC}^2}{4P_u} = \frac{3(18.2)}{4(2.5)} = 55\Omega$$

Since at 50 MHz, the number of turns needed for L_1 will be rather small, and also, since the collector load impedance is very close to the 50Ω antenna impedance, we will assume a 4:1 turns ratio.

As shown in **Fig. 6**, coil L_1 transforms R_L to another resistance R_L''. This is given by the standard transformer impedance equation

$$\left(\frac{N_1}{N_2}\right)^2 = \frac{R_L''}{R_L} \qquad (11)$$

Since turns ratio is 4:1 and $R_L = 50\Omega$

$$\left(\frac{4N_1}{N_2}\right)^2 = \frac{R_L''}{50} = 16(50) = 800$$

$$R_L'' = 800$$

Let's assume that a loaded Q (Q_L) of approximate 8 or better is desired. Values of loaded Q in the range of 5 to 10 are practical to achieve.

Now, we can calculate C_2

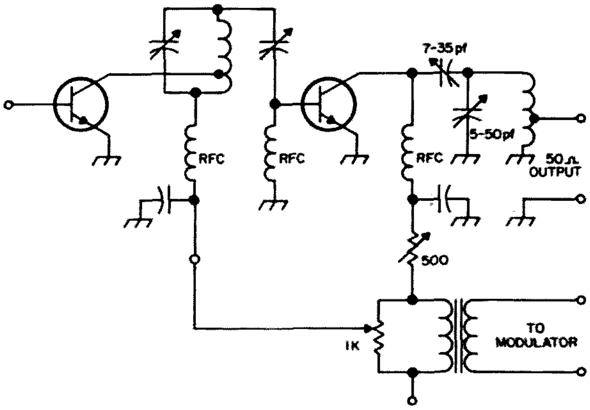

Fig. 9. Complete 50 MHz power amplifier stage and part of its driver. The driver must supply 75 mW for 2.5 W output.

$$C_2 = \frac{Q_L}{2\pi F R_L''}$$

$$= \frac{8}{6.28 \times 50 \times 10^6 \times 800} = 31.4 \text{ pF} \qquad (12)$$

and

$$L_1 = \frac{1}{(2\pi F)^2 C_2}$$

$$= \frac{1}{(6.28 \times 50)^2 \times 10^{12} \times 31 \times 10^{-12}} = 0.333\,\mu\text{H} \qquad (13)$$

Using a coil nomograph, this turns out to be a 7-turn, one-half-inch diameter by one-inch long coil. Tap 1¾ turns from cold end.

Next, the value of coupling capacitor C_2 is calculated.

$$XC_2 = R_C\sqrt{\frac{R_L''}{R_C} - 1} = 55\sqrt{\frac{800}{55}} - 1 = 55(13.8) = 210\Omega \qquad (14)$$

$$C_2 = \frac{1}{2\pi F X_{C2}} = \frac{1}{6.28 \times 50 \times 10^6 \times 210}$$

$$= \frac{1}{66 \times 10^9} = 15 \text{ pF} \qquad (15)$$

The complete 50 MHz RF power amplifier and part of a driver stage is shown in **Fig. 9.** As shown, the driver stage can be designed using a similar matching network. The load for the driver will be the input impedance of the 2N3553 final transistor which, for all practical purposes, can be considered as the base spreading resistance (r_{bb}') of the transistor. For the 2N3553, r_{bb}' is typically 12 ohms. Therefore, the network must transform 12 ohms to the impedance the driver needs to see to develop the required drive power. The driver can be designed using the same procedure as given for the final. From **Fig. 7,** the driver must supply about 75 mW of power to the base of the 2N3553 to drive it to a 2.5 watts CW output. Since the driver should be modulated to improve down-modulation, the needed drive for peak power output of the final is provided by peak modulated power from the driver. Usually, modulating the driver between 25 and 35% is sufficient.

Potentiometers are shown in the modulation circuit to permit adjusting modulation for optimum performance. The pots can then be removed and replaced with fixed resistors after adjustment. Since the driver is being modulated the modulation to the final must be reduced, (i.e., driver modulation plus final modulation must not exceed 100%).

. . . Thorpe

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A 75 Watt Compactron Twoer Linear

Build this simple, inexpensive linear to multiply the output from your Twoer 25 to 30 times.

In response to many inquiries about the Twoer linears described in previous 73's[1], I designed another one using a modern, readily available, low cost tube that I've used before on six and two. I have had this linear on the air for some time now, and find that the change from the one watt Twoer output to a well-modulated 25 to 40 watt carrier is certainly a worthwhile project for the average Twoer owner.

1. K1CLL's other Twoer linears were in the September 1964 73 (used 8025 and 815) and January 1965 73 (2C39).

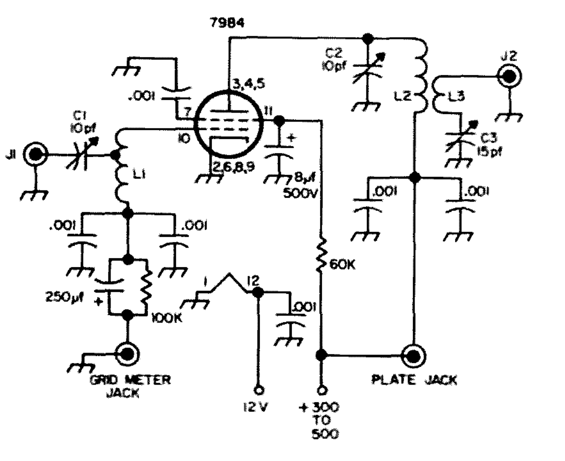


Fig. 1. Schematic of the Compactron Twoer linear. Coil data is given in Fig. 2.

Some notes on AM linears

Information is available on good AM linears, but you have to dig for it. I have been told that many large AM broadcast stations use AM linears and I do not doubt it. Any type of power linear amplifier requires a few simple adjustments, but they're worth it to get an exact, well-modulated reproduction of the input—but 30 to 40 times stronger. As far as performance goes, typical reports have been: "excellent modulation," "modulation clean, clear and crisp," "recognized the Twoer modulation right away." I have checked the RF output with light bulbs and find that 50 watts input gives about 25 watts out. 75 watts in gives about 40 out with 85 to 100% modulation.[2] And no modification of the Twoer. Just plug it in and talk.

Getting good results from an AM linear is easy if you adjust the following controls:

1. RF tuning in the driver. The Twoer must be adjusted for best modulation. This is especially true of the final grid and plate tuning.

2. Some comments about that "85 to 100% modulation: many Twoers modulate downward instead of upward. That is, modulation reduces the power output instead of increasing it. This is the "typical Twoer sound" referred to. Thus this linear might well handle 100% downward modulation, but I doubt that results would be completely satisfactory with 100% upward modulation and 50% efficiency. However, it's very easy to check with a scope. See the article in the December 1964 73, p. 28 by W8HHS (W1CER) for information on improving the modulation of your Twoer. WA1CCH

On the Twoer, these are internally adjusted controls, but once set, they can be left alone.

2. Variable drive to the linear, Cl. You might think this is unnecessary with the Twoer as a driver, but it can easily overdrive the linear. Note that Cl is insulated from ground. The length of the drive cable isn't critical if you have a good match, but I used 21½".

3. Grid bias. The most common type of grid bias for a linear is fixed bias. You could use that in this linear with a simple voltage doubler from the 12 volt filament line. However, here I've used a rather rare type of bias supply that is only suitable for AM linear service, not SSB linear. The amplifier is in AB2 drawing slight grid current. This rectified, furnished bias. The bias is kept stiff by the long time constant of the 100 k resistor and 250 μF capacitor in the grid circuit. Unfortunately, this arrangement furnishes no protection against loss of drive for the amplifier tube since loss of drive means no bias and results in very high plate current and excessive dissipation in the tube. So make sure that the Twoer is always on when you turn on the B+ for the linear. This type of amplifier often uses a clamp tube for protection.

4. Screen voltage. This is important. Changing the screen voltage results in changes in the modulation. The effect is quite noticeable with a variable resistor between B+ and the screen of the linear. Turning down the screen voltage increases the upward modulation percent.

5. Output loading. You can just vary the coupling of the link between the linear plate tank and the antenna, but it is much easier if C3 is used, as you can then adjust the load while operating and listening. The combination of a semi-adjustable link and C3 makes it easy to work with. Note that linears like heavy output loading.

You must listen to the modulation when adjusting the above controls. See the June issue of 73, page 20, for how to do this. It's easy to do the job with a sine wave AF generator and an oscilloscope but lads with those items are generally not Twoer operators.

Exact construction details

I will guarantee that if you build the linear as shown in **Figs.** 1 and 2 it will work. The easiest way is to start with a copper-clad baseboard and build up from there. Mount the vertical brass walls and the 12 pin socket (use a tan bakelite socket, not a horrible black one). Then solder the four cathode leads and

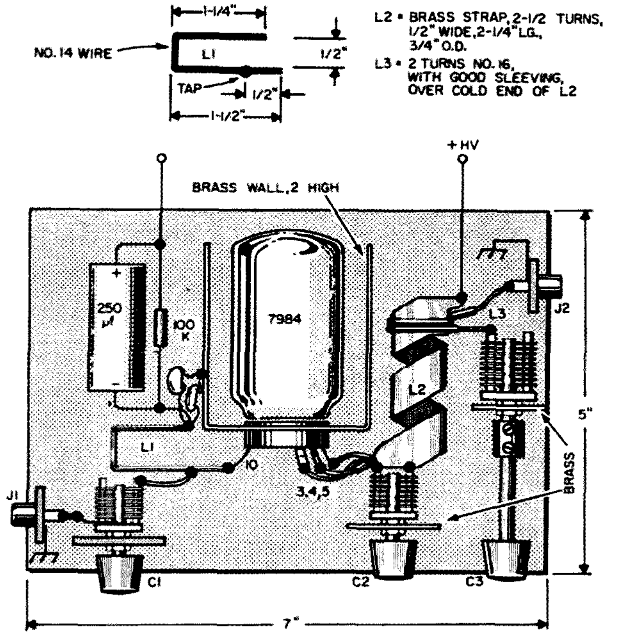


Fig. 2. Layout of the 7984 Compactron Twoer linear.

one heater lead to ground, and also the three bypass capacitors, two on the screen leads and one on the 12 volt heater pin.

The input circuit of the 7984 is a little tough, but I got the best results on 144 MHz with a short heavy loop fixed-tuned to a quarter wave. This is LI in **Fig.** 1. It really does the job, with most of the quarter wave ***inside*** the glass bottle. Either loop of capacitance coupling may be used with it but I find the Cl variable as coupling and drive control to be best.

I paid great attention this time to get the proper automatic bias for AM linear operation. The use of a 250 μF capacitor across the 100 k resistor really holds the bias in place. There is no difference in the modulation quality between this type of bias and fixed bias in AM linear service. I tried it several times.

I put a small brass shield across the socket between the input (grid) and output (plate) side because Cl looked a little near the plate leads, but you can leave it out as no self-oscillation was found.

The plate tank is similar to one already described with the addition of a larger antenna output link and C3. This greater amount of coupling allows C3 to be used as a variable loading capacitor, which makes it easier to adjust the plate circuit for heavy loading, one of the requirements for low distortion with a linear. Use a bakelite shaft extender on C2

and C3 to keep fingers off that 500 volts! The rear panel has the grid and plate meter jacks. Use shorted phono plugs in these after tune-up to free your meters for other service.

Tune-up

Check the Twoer for RF output as indicated in its instruction manual. Connect an RG/58-U cable from the Twoer antenna jack to the linear input J1, and check for grid voltage on the 7984 with heater on but no plate voltage. The point between LI and the 100 k resistor in **Fig. 1** should be 28 volts, or near it. This voltage will rise slowly, while charging the 250 μF capacitor. This is a nice feature as it leaves plenty of bias on the tube, just like a battery!

Current through the grid meter jack and the 100 k resistor should be about ½ mA.

It is best to apply plate voltage in steps. If you don't have a Variac put some resistance in series with the HV lead. Some 115 volt lamps in series are good for this. Just watch those fingers though!

A good plate dip should result on rotating C2, with no load on J2. Plugging a 25 watt bulb into J2 should produce light immediately on turning on the HV. I generally "sneak up" on the 75 watt operation during tune-up. This latter power calls for 500 volts and 150 mA.

Screen voltage is 140 and screen current is 5 mA. Due to the linear's preference for heavy loading very little plate dip will be found at the proper linear operating condition. Plate current at around 150 mA with the RF tank loaded a litle beyond maximum RF output. That is, with the beam in use connected, full plate voltage (whatever you have, 300 to 500) on, first load the plate circuit, via L3 and C3, for maximum RF output as indicated by a small pilot lamp, no. 48 or 49, 120 milliwatts, in series with a 1 to 5 pF trimmer across the output cable, or whatever means you have to indicate *antenna cable* energy. Do *not* allow this indicator to be coupled to the plate tank.

Then, listening to your own voice modulation with a small monitor (you can use a tape recorder if you have one, which avoids the padded earphones), adjust the output coupling, L3 and C3, for a little more loading which will increase the plate mils, flatten out the dip, and decrease slightly the RF in the cable. Only a little, though. Retune the grid input for a check, and then leave it alone. The adjustments are very stable and unless you change beams you should have "excellent" modulation reports from then on.

You can also use this same amplifier later for class C or SSB with only slight bias and screen voltage changes.

On the air

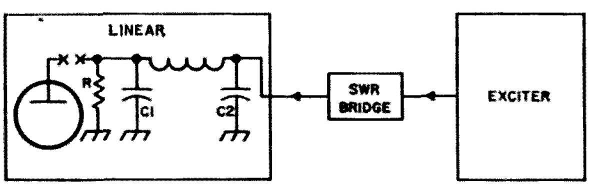
This has been pretty well covered in the modulation reports. The difference in S reports between the barefoot Twoer and the 40 watts out may surprise you, though. Especially if you use another receiver and can hear the other DX like they can now hear you!

. . . K1CLL

Tapping of Pi-Section Inductors

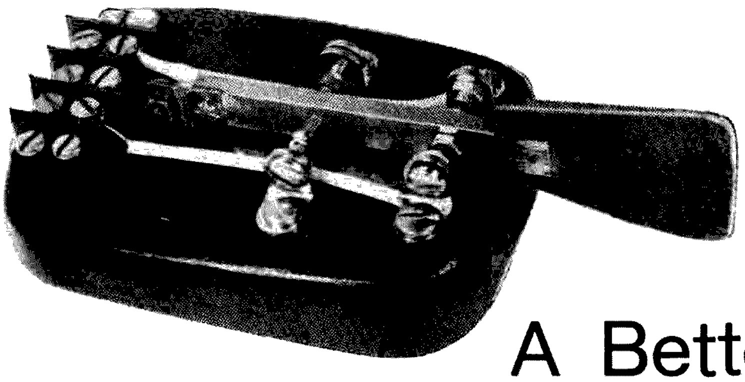
Since many amateurs design their linear amplifier around a favorite tube, only rarely is the plate resistance accommodating enough to allow the use of commercial inductors. So one has to move taps around and, more often than not, the end result is guesswork. I present here an almost foolproof scheme for tapping inductors that does not seem to be general knowledge.

After completing the pi-section, compute the proper values for C_1 and C_2 in the middle of each band. Then disconnect the tube from the pi-section and replace it with a composition resistor of value equal to the plate resistance. Next on each band replace the variable capacitors C_1 and C_2 with fixed value types of the correct value for the middle of the band. Next tune your exciter to the middle of the band and connect it through an SWR bridge to the output of the pi-section. Then applying drive commensurate to the wattage of the composition resistor, tap the inductor for minimum SWR. Do this for each band in turn.



Thus 1:1 swr insures that the 50 ohm output of the pi-section will match exactly the load resistance of the tube or in practice that the tube will match to the antenna. This same technique has many applications as for instance to match grid circuits for maximum transfer of power.

. . . Chuck MacCluer W8MQW



Ed Marriner W6BLZ
528 Colima Street
La Jolla, California

A Better Sideswiper for Electronic Keyers

The local radio parts store, and metal supply have enough simple parts to build a good sideswiper for electronic keys. This idea is better than a makeshift key using a hacksaw blade or tearing up a regular telegraph key.

All of the parts for the key are mounted on a lead base to keep the key solid on the operating table. Lead is also easy to drill and tap, and should offer no problem for the home constructor. The mold is made from a sardine can, and the round corners give a pleasing appearance to the key.

Ed has been licensed since 1931 with one call-W6BLZ. He is a System Engineer for the U.S. Naval Electronics Lab in San Diego and has had 350 articles printed in various magazines.

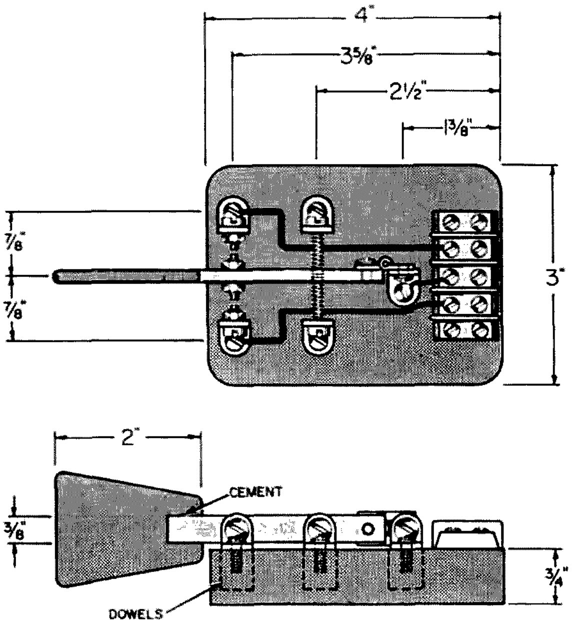


Fig. 1. W6BLZ's sideswiper for electronic keyers. The base is made from lead molded in a sardine can.

Construction

First go to the grocery store and select a nice can of sardines, and a size suitable to your liking. Dispose of the sardines and trim the metal off to the edge of the can and clean it out thoroughly. Heat some lead in a small crucible or small skillet and pour the lead into the can. When the lead has cooled, tear away the tin by using pliers or diagonals. Any roughness left on the surface of the lead can easily be filed away with a rough file, and then smoothed with sandpaper. Use the bottom side of the can for the top of the base. Spray the base with lacquer after all of the holes are drilled and tapped.

To make construction simple, the contact leads are fastened to a Jones type barrier strip mounted on the base by tapping in 6-32 holding screws. All of the radio brackets are found in the Walsco displays in the parts store. The brackets are all fastened by tapping into the lead. The two front contacts for dot and dash are mounted on an insulated dowel of either fiber or wood, which have been driven into a ⅜ inch hole put in the lead.

The contacts for the key are made simply from 8-32 machine screws. These were used because the hole in the 90 degree bracket is just the right diameter for tapping 8-32 threads, and makes a good adjustable contact. A cap head type screw is best so that it will clear the 6-32 head holding the bracket to the base.

A ⅜ inch ¼ metal brass bar was obtained at a metal supply house for the lever arm. It is fastened to the base by attaching a small brass hinge which has been sawed in half. Having tried all of the pivots and bearings, the cheapest and best turned out to be this hinge which only cost 40 cents for a set of four. Any slop in motion can be corrected by pinching the metal going around the pin. It is better to attach the hinge to the lever with a screw and then drop a bit of solder on it with a small torch or large soldering iron. The particular hinge was type #5075XC, manufactured by the Brainerd Mfg Co. East Rochester, N.Y., it is a ¾ inches x ⅝ wide, solid brass butt type hinge.

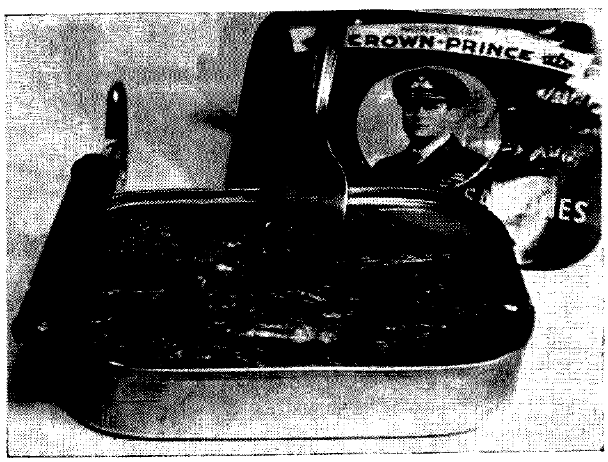
Two holes were drilled into each side of the lever arm to accept the ends of the tension springs to keep them in line. The springs were found in a hardware store and had a light tension. They could be taken off from surplus relays. The springs should be soldered on to the ends of the adjustment screws going through the bracket.

Adjustment

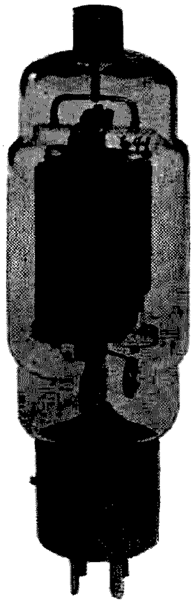
Once the key is finished, insulated wires can be run back from each contact to the terminal strip. Since the base is ground, a screw can be run through the middle terminal screw and tapped into the base making it necessary to only run two wires from the contacts. The two springs can be used to center the lever arm, or stops can be screwed into the base to suit the operator adjustment.

This key is easy to make, functions smoothly and looks a little better than many other make shift devices used for keying the automatic keyers. Besides, think of the enjoyment Pussy Cat will get eating all those sardines!

. . . W6BLZ



Source of the mold for the base of the key.



Dr. Howard Klein WB2EPG
123-60-83rd Ave.
Kew Gardens, N.Y. 11415

Replace Your 811's with 572B's —The Right Way

Due to the popularity of the 811 tube in both commercial and homebrew linears several manufacturers produced a replacement for the 811's capable of greater plate dissipation and in general a more rugged tube. This was the 572. With its introduction several years ago there were several references to the exchange of 811's for 572's. All of the references I had seen merely suggested the replacement of the existing 811's with the 572's without any further change. This seemed like an easy way to increase power without effort and with small expense. How this increase in power was actually achieved was given little thought.

In my rig which used four 811's, the power supply, a conventional full wave bridge rectifier circuit, delivered 1700 volts at no load and 1500 volts at 600 mA. By replacing the 811's with 572's the output was found to be substantially the same but the odd order distortion products were found to have increased markedly. The only discernible advantage was that the 572's showed no color on the plates.

After some thought and a perusal of the spec sheet on the tube, available from the manufacturer, the following changes were made. It was first deemed necessary to raise the plate voltage on the tube to about 2500 volts. This was done by jumping the input choke which raised the no load voltage to 2700 volts in my case. At the same time it was necessary to increase the filter capacitor rating to a safe working voltage. I originally had five 100 μF electrolytics rated at 450 working volts in series shunted by 100 k resistors. I added three more similar electrolytics and shunted each of these with like resistors. The transformer as used originally had a dual winding secondary, for B plus and filament voltages. Since this was felt to be poor design an outboard filament transformer was incorporated. This also allowed the original transformer to operate without saturating under full load.

Under these conditions the rectifiers must be carefully evaluated, particularly if they are solid state. In my power supply I have three silicon diodes each rated at 1700 piv and 750 mA and each shunted by a 470 k resistor and a .01 μF capacitor in each leg. It is also prudent to place a .003 μF silver mica capacitator of sufficient voltage rating across the transformer secondary.

A further change: 811's are usually operated with about 4.5 negative volts of operating bias. The tube manufacturer for the 572 recommends zero bias so the 4.5 volts was removed.

If the preceding conditions can satisfactorily be achieved the limiting factors now become the plate transformer, the exciter driving power and the FCC. To drive four 572B's to a kilowatt input about one hundred watts is required allowing for circuit losses. Under test conditions into a dummy load the tubes were loaded to one amp. The plate voltage dropped from 2700 volts at no load to 2200 volts at one amp. The output as measured with a wattmeter showed 1400 watts. This is an efficiency of about 64%. Under actual on the air conditions the rig is loaded to 400 mA while the plate voltage is 2250 volts.

The removal of the choke raised questions as to the adequacy of the regulation. However the voltage variation was found to be within tolerable limits. Operating both in the SSB and CW mode, checks made with a scope and on the air indicated the signal was clean and free of excessive distortion products.

An excellent source for these tubes is Scientific Instrument Co. of Union, New Jersey. The price is $12.50. In a recent communication with the manufacturer, it is stated that the tubes have been further improved, the exact nature of which will soon be forthcoming. Waters Manufacturing also distributes 572B's.

. . . WB2EPG

Photo courtesy of Scientific Instrument Co.

Joseph Zelle W8FAZ
1227 Addison Road
Cleveland, Ohio

UB5UG's Five Band Vertical

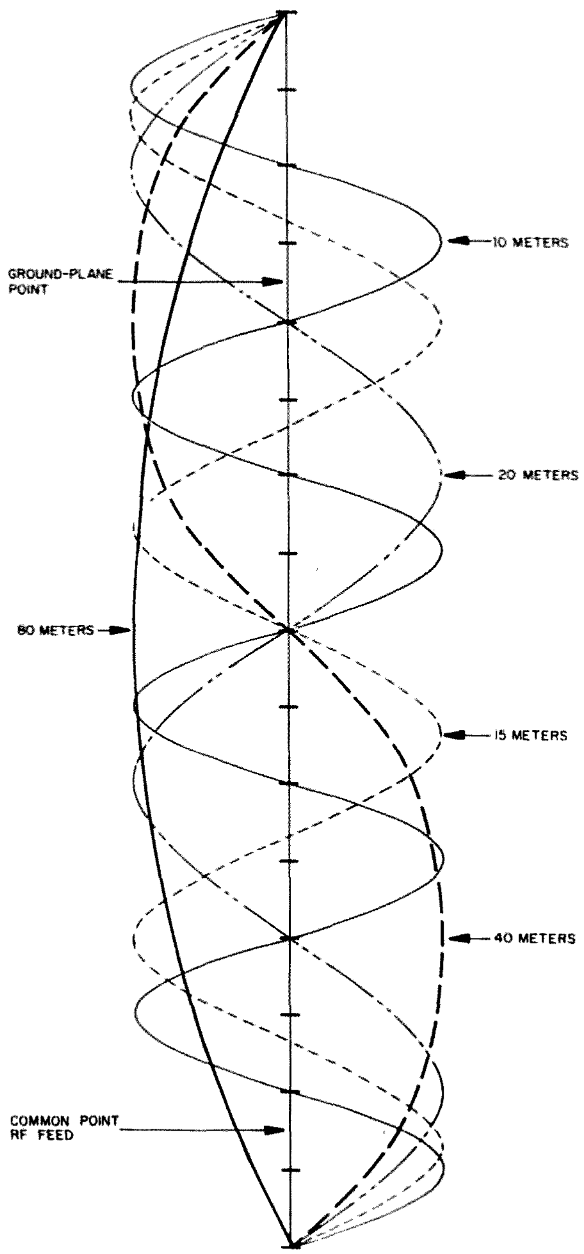


Fig. 1. Standing wave distribution for harmonically related even modes of excitation. Note that these curves are theoretical and assume equal power on the frequencies, constant efficiency, no mismatches and no ground plane effects.

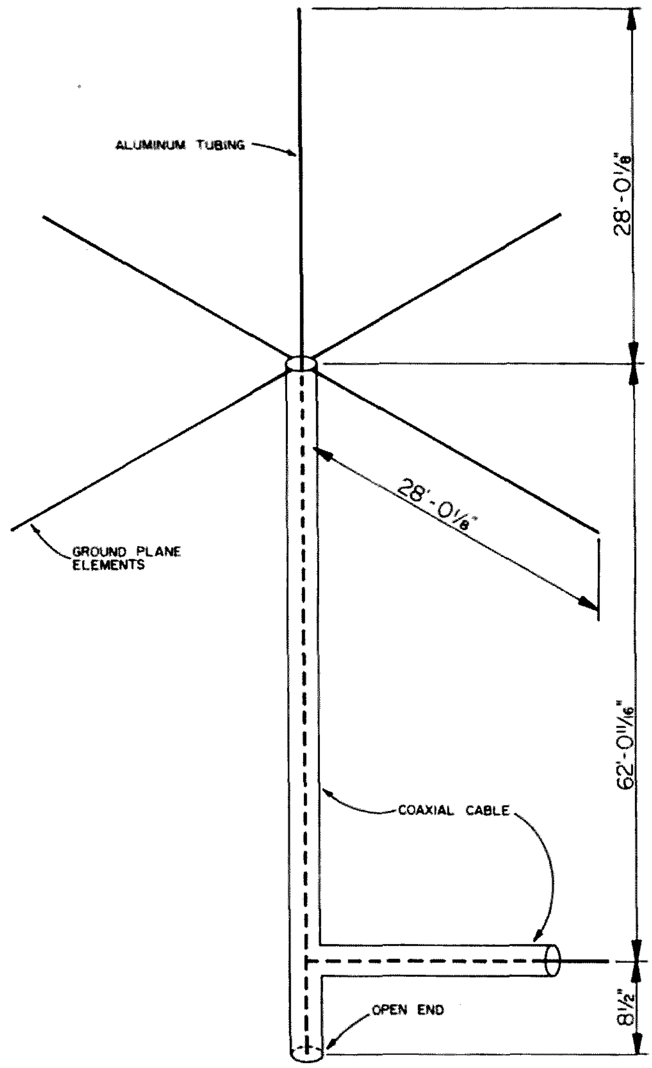


Fig. 2. Dimensions and construction of UB5UG's all-band vertical.

For the past few years, UB5UG of Kiev, has been operating a multi-band vertical antenna that requires no switching and no traps. Moreover, the antenna is excited by a single rf feedline. In theory, the antenna system is quite straightforward, but the construction does require some ingenuity.

Basically, the system acts as two antennas. The frequency of operation determines which mode will take over. On eighty meters, it operates as a half-wave vertical, with the ground plane elements tending to act as a "hat." This effect improves the current distribution both on eighty and forty meters for low-angle dx.

On twenty and fifteen meters, the upper portion operates as a ground plane antenna. On twenty, the protruding rod acts as a 0.5 λ radiator, while on fifteen as a 0.625 λ radiator. Good enough results have also been obtained on ten meters.

Probably the system could be extended in both directions, with some additional tuning arrangements to operate on one hundred sixty meters and six meters. Approximate theoretical standing-wave distribution for the five main ham bands is illustrated in **Fig. 1.**

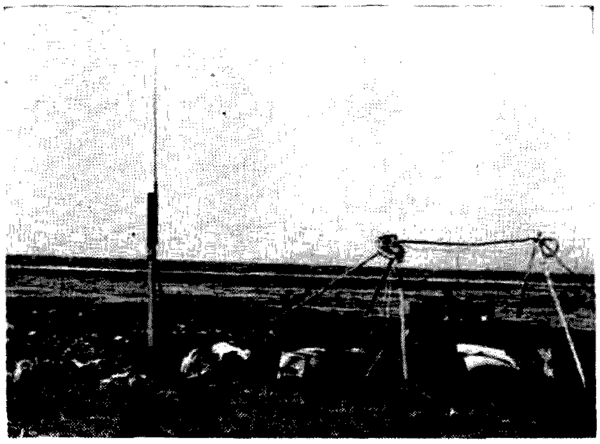
Like the horizontal Windom all-band antenna, the point of input feed represents a compromised low impedance point for all the bands. The exact point, together with all the other dimensions, is shown in **Fig. 2.** An SWR of 3:1 to 3.5:1 on eighty is reported by UB5UG. On forty, twenty, and fifteen meters it is around 1.5:1, and is 2:1 for the ten meter band. Most efficient radiation occurs in the twenty and fifteen meter bands.

Not much is said about the physical aspects of the antenna. The basic vertical length consists of 72 ohm coaxial cable. The feedline is also 72 ohm coaxial cable. Above the vertical coax section is a 28-foot rod of 1½ inch tubing. Ground plane elements consist of antenna cabling mounted on hazelwood beams.

As a self-supporting vertical radiator, the antenna may present some formidable problems. Probably the simplest solution would be a wooden pole with wooden cross-arms. The cables and rods could then be mounted to this frame via stand-off insulators. To the ambitious and enterprising radio amateur confronted with such a vertical solution to his antenna problem, the actual structure should be just another challenge.

. . . W8FAZ

This article based on an item in Soviet Journal. *RADIO*, No. 9, 1960, page 44, entitled "Five-band Vertical Antenna," by Y. Myedinyets (UB5UG).

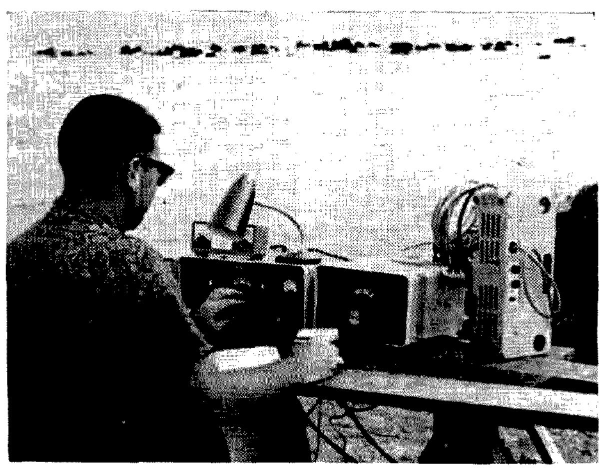


To the left is Don setting up his gear (note the foam rubber pillows) on Minerva Reef, where he operated as 1M4A. Above is a shot of part of this luscious tropical island. How would you like to be shipwrecked there?

Don Miller W9WNV DXploring

Here's Don operating 1M4A.

Maria Teresa Reef seems to be pretty moist. Don is shown here setting up his vertical on the dry part of the island. That isn't sand around the rock; Don operated with his feet in the water. The boy isn't identified.



Here's Don operating FO8M on Maria Teresa.

Gus Browning W4BPD
Cordova, South Carolina

Gus: Part 13

The operation in Monaco was a success and everyone knew I was on my way. Even had a FB QSO with Harvey Brain VQ9HB to let him know I was on my way to the Seychelles and to have the man who owned the boat have it all shipshape to depart when I arrived there. I made a few stops along the way between Monaco and Bombay. Met some of my old friends in Cairo, Beirut, Aden, a few others. Finally arriving in Bombay a few days before the S.S. Kampala was to depart for VQ9 land. The usual way to get to VQ9 land is by way of Mombasa, Kenya. This is a little cheaper than by way of Bombay, but I tried to get reservations on one of the boats six months in advance and was informed that all reservations were filled up for over a year in advance. It seemed tht every VU2 that was living in Africa was on a one way trip back to VU2 land. Apparently they were of the opinion that things were not going to be good for them in Africa any more and they were going back to their mother country. Passage was arranged very easily from Bombay to the Seychelles. In fact the boat seemed to be about only half filled.

Remember the day I departed from Idlewild we shipped a number of items via air freight to Bombay for reshipment to VQ9 land on the SS Kampala along with me. It was good I got in Bombay a few days before sailing day because there was nothing at the airline offices for me at all. Mind you I had been delayed in arriving in Bombay about twelve days, and I arrived about four days before departure date for the Seychelles. Even with all this extra allowance for air freight shipment delays, etc., nothing had as yet arrived in Bombay. I could not possibly depart on that boat unless I saw my power plant and the other material on the ship. It would have done me no good to arrive on the island without at least the power plant which I was going to use at Aldabra. It took a lot of DX telephone calls to finally locate the air freight shipment. It somehow had been offloaded in Karachi and was just laying there for some strange reason. To be truthful every experience I have ever had with air freight shipments were always like this. The shipment arrived in Bombay one day before sailing day to the Seychelles and on top of that it was a legal holiday. Now you try getting something from Indian Customs on one of their holidays when customs are closed up. Then I had to pay extra for a customs guard to come along with the shipment to be sure it was put on the ship and that it did not end up in India. You don't fool these Indian customs fellows, they trust no one at anytime under any condition. Now all of this monkey business cost quite a few extra rupees. I was the one who ended up paying all this of course and also the DX phone calls too. I tell you these unexpected costs will eat a big hole in your pocketbook. Trying to keep an exact account of such expenses are a real headache and I suppose I have lost quite a good sized sum of money in trying to keep a record of expenses. You have the extra trouble of trying to keep your records in dollars and spending rupees, and every time you move those hands are out for backshee (tips), and these people are real professionals when it comes to extracting the last rupee from you. I was lucky in Bombay to have met Dady VU2MD, Tipi VU2TP, VU2RX and VU2CQ. They took very good care of me with transportation all the time to wherever I wanted to go, and they knew all the shortcuts in dealing with their people or I suppose I would have ended up spending a lots more than I did. These VU2 boys were very wonderful to me and knew how to roll out the Red Carpet. Later on I found that every one of the Indian Radio amateurs was the same way. They will do anything in the world for a fellow ham. After spending a few days in Bombay I could easily see where the expression the "masses of India" came from. You cannot picture in your mind the amount of human beings you see on the streets of Bombay. Later on I found that Calcutta was like Bombay only multiply what you see by about 3 and you have some idea what a tremendous amount of people there were on the streets. I soon found out to not give any rupees to the beggars on the street because before you can bat your eyes there are a hundred where they came from. About the best way, at least with me, when the beggars approached you were to look straight

ahead and not ever even let them know that you see or hear them. Trying to overcome the giving of backshee to them is a very difficult thing to do. It's sort of like trying to plug up a dike made of screen wire with a few toothpicks, the little relief you give is so insignificant you may as well not even bother. At least that's how it seemed to me.

You want service in a restaurant, just go to an Indian restaurant, there are usually more servants than there are tables and when you get ready to leave it seems like everyone of them waited on you. I mean when you see all the hands sticking out for their tips. The Airlines Hotel in Bombay is a pretty good place to stay when you are there, their prices are fair and, boy, you do get service. The day to depart from Bombay arrived and the usual rush down at the boat took place, customs was cleared, everything that was shipped by air freight was placed in my cabin, everyone was paid off, I shook hands with the VU2 fellows, the anchor was lifted and we were away for the Seychelles. At that time the fare was around $120.00 for one way passage from Bombay to VQ9 land. This was tourist class, the cabins were very clean and the service fine.

I met a man from Zanzibar who had gone back to Pakistan to see some of his relatives along with his family. He had a brand new Mercury car that he was taking back to Zanzibar on board the ship. I told him that I might get back to Zanzibar and he insisted that I make his home my home when I arrived in Zanzibar. He was in the ivory business and from what I saw of him and his family he was very successful. I still have his address and telephone number in my little white book. But since reading all about what happened down in Zanzibar the past few years I guess he is not there any more. Maybe he was lucky enough to have escaped the fate of some of the others that I read about. I often find myself wondering about him and his very nice family. If any Americans ever get back into that country to do any operating I will be very much surprised. That is not unless there is a big change in their attitude from what it seems to be at this time. When I was in Zanzibar a few years before things were so peaceful and quiet, and everyone seemed to be doing such a fine business. Maybe some day I will get another chance to go there if for no reason other than to see if there has been many changes from what it was when I was there.

For the benefit of any of you fellows who have never made an ocean voyage on a large ship, let me tell you that you have missed

some of the most pleasant things in this world. The meals on these ships are out of this world. Three or four different kinds of meat for every meal and everything else that goes towards making some of the finest eating you will ever have. You know when you pay them the $120.00 for the boat passage you are also paying for all the food for the entire trip. If time is not a pressing matter with you I cannot over emphasize or over-recommend that you take a boat trip the next time you go overseas. Setting up there on the sun deck watching the flying fish sail away when the ship approached them, and occasionally seeing a whale blow in the distance, or just watching the sea gulls following the boat makes things so peaceful and restful. Every morning usually you could see any number of porpoises parading along with the boat usually in schools of three or four. The trip from Bombay to the Seychelles took five and one half days and I must say they certainly were very restful days. Every night there was a movie and afterwards there was dancing with the orchestra. They even played some twist music and this did liven up things a bit. Everyone played many different games all during the day. All I can say is "take yourself an ocean trip by boat."

Remember the only way to get to VQ9 is by boat either from Bombay, Karachi, or Mombasa. Ships sail about once per month and occasionally during certain months twice per month. I tried talking the wireless operator into letting me do some "maritime mobile" but could never get to first base. The fellow that the boys from Kansas City and I met before either was not working on the ship any more or was on leave. I even talked to the captain about it and he just could not understand why a fellow would want to operate from a ship out in the middle of the Indian Ocean. I finally gave up on this and just acted like all the other passengers on board. I sat back in the deck chairs, drank my tea twice daily, was first in the dining room when they rang the bell, went to bed each night early and read a lot of books from the ship's library. The trip was enjoyable and I arrived at VQ9 in a very rested up condition. But I would have preferred it a lot more if I could have been operating W4BPD/MM I am sure. I was busy getting my logs in order, writing a few letters, and sort of going over the equipment. I wanted everything to be "go" when I arrived at VQ9 and was hoping that Harvey and Jake (the owner of the boat) would have everything ready to go also.

Early in the morning of the fifth day, Mahe, the main island of the Seychelles group was sighted off in the distance, first as a sort of long mountain peak sticking up out of the water with a few of the other smaller islands nearby as smaller mountain peaks. As the ship drew closer the mountain gradually changed into the general shape of an island. A little later on the palm trees and then the beaches could be seen with the breakers breaking on the beaches. The Kampala being a fairly large ship always anchored out in the deep channel about one mile away from the end of the long pier. Many of the island boats always come out to meet the ships when they anchor in the channel. Some pick up the passengers that are leaving the ship at Mahe, and also the ship passengers who want to come ashore to do a little shopping and sight seeing. The ship always stands at anchor for six or eight hours giving everyone plenty of time to come ashore and get back on board to continue on their way to Mombasa. The little passenger launch picked up the few that was leaving the ship, I think there were only about four on this stop.

When the passenger launch stopped to drop us off at the customs and immigration office on the long pier, good old Harvey was there as usual waiting for me. To me each moment was a little bit more exciting then the one before, knowing that all the DXers back home were scanning the bands for my signal. It has always been a thrill to me to know I had so many friends and let's call them "Gus Watchers" like W6ISQ (I love them dots) wrote about some time ago in QST. This fact never leaves my mind when I get overseas, and I try my darndest to appear on the bands as often as possible because I don't want to let them down. I remember the many hours I have spent back at W4BPD waiting for some rare DX station to appear. Many times of course I have been disappointed because some of the stations on these DXpeditions just were not dependable when it came time for them to appear on the bands. I very badly wanted by reputation to be one that could be depended upon to be on the air especially when skip was at its peak, both before and after the peak had come and gone. You DXers remember when I am on DXpedition I am actually more anxious to work you than you are to work me. I have lots more at stake then any one station has. I always remember that lots of money has been spent getting me to these rare spots and I want everyone to feel that they have not spent their money uselessly.

Immigration and customs were no trouble

at all as is usual in VQ9 land. They did check my things a little bit closer this time, wanting to know how long I was going to stay there, where, and the purpose of the trip. My usual answer to most questions are a flat statement that I was a "tourist" and radio was my hobby. At least those were my answers in VQ9 land. You know they like tourists down there. Oh yes this is one of the few places left in the world that is not overrun with tourists and tourist traps with the usual boosting of prices to take in the tourists. Someone told me the ratio of ladies to men on the Seychelles are something like nine to one—That's a very high SWR and it does make life very interesting down there. I think this ratio is not quite true, but it's still pretty high.

Their only town is Port Victoria with that town clock that strikes twice on each hour. The entire population of Mahe is about 40,000 and the island is about 35 miles long and some 3½ miles wide. The color of the people are anywhere from jet black to 100% white. There is no predominating color there, everyone there lives very peacefully with every other one. No one seems to take life very seriously there, and no one seemed to me to be working very hard. They all really take it easy and no one ever seemed to be in a hurry to do anything. Every morning at about ten there is that tea break and of course at four in the afternoon they have their tea break again. This is one thing that everyone does. The stores all close at about twelve noon and open up again at three.

Port Victoria is the only seaport town on the island and this is where all the ships come to. They have two piers, one called the long pier which is about 1,000 foot long, extending out towards the deep channel where the big boats anchor. Along this pier you will find a few ship repair shops, Customs and immigration offices, and also the turtle pond where they put the live turtles they bring back from Aldabra Island. They keep the turtles there until they are sold. Then there is the short pier which runs parallel with the long pier, it extends out about 500 feet I would estimate and is about 500 feet away from the long pier. This is the pier where Harvey keeps his boat, and others with small boats anchor. Harvey and I walked over to the short pier and out near its end I saw his boat at anchor in the same place it was when the Kansas City boys and I departed from the islands about two years from the date I arrived there.

I was introduced to the owner of the small boat that was to carry us to VQ7 land—a fellow named Jake. The boat was named the Lua Lua. This was a very fine boat, 36 ft. long and about 8 foot wide, made out of 1⁄16 inch steel plate. There is a good story behind this boat and its owner. Jake and his family had been living in Northern Rhodesia for a number of years, just across the border from the Katanga province of the Congo. Jake was in the auto and truck body business. He was from Austria and had been down in Africa a long time. The Congo trouble had finally spilled out of the borders of the Congo and a number of houses very near their little town had been burned and a number of people had even been killed by the Congolese. Apparently they did not know exactly where their border stopped or maybe they did not care. Anyhow Jake and his family decided their days in Africa were numbered and they wanted out. He found a description of the boat in some magazine, maybe Popular Mechanics or something like that. He had lots of sheet steel on hand for building truck bodies and a fully equipped metal shop, and he had the will to undertake the construction of the boat right there in Northern Rhodesia a very long way from any ocean. He even ordered a second hand sextant and instructions as to how to use it. Mind you he had never in his life been at sea before. After about six months of hard work the boat was finished. He used every inch on the boat for some useful purpose. Practically each inside wall was covered with metal built cabinets to hold various items. The diesel fuel tank was built in and the fresh water tank built in. There was a place for each item and each item was in its place. The boat was hauled by trailer overland from northwestern Northern Rhodesia all the way to the Indian ocean, placed in the water and Jake by himself sailed it all the way to the Seychelles. His family (wife and daughter) went by ocean liner from Mombasa. Maybe they did not trust Jake and his navigation with that second hand sextant, or maybe they did not trust the boat, or maybe it was a case of not trusting both. Well here was Jake in his boat in VQ9 land safe and sound. The boat was basically a sail boat with the small diesel engine used for docking purposes mostly. The mast I would estimate was something like 60 foot high and the leaded keel was very deep also to compensate for that extra high mast. The boat looked good to me and I was very sorry that Lee Bergren WØAIW and the boys form Kansas City were not there with me to look it over. I am sure they yould have fallen in love with the little ship. Everything was so ship-shape, everything freshly painted, the engine purred like a kitten. It was not like other

boats I had seen before in and around VQ9 land, not by a long shot. The nicest part of it all was Jake was ready to go when I arrived there.

After the usual preliminaries and customs were attended to, the owner of the Aldabras consulted, and his letter of introduction given me we were ready to go. Away we went down to "Temolgees" store and bought all the supplie we would need, a 50 gallon drum of gasoline, lots of Bully Beef I think Harvey's favorit food), cans of soda crackers, plenty of tea, sugar, canned cream, and a lot of other items. Harvey knows what you will need and he did a good job in chosing the right amount of food, fuel, etc. A ll of this took about three days, during this time I checked into the Hotel de Seychelles and did some operating. The bands as usual from VQ9 land were very FB. I told the fellows that Aldabra would soon be on the air. I suppose the fellows back in the USA were already thinking of their excuses to tell the places they worked at why they would not be at work in a week or so.

The Hotel de Seychelles is one of the nicest Hotels in VQ9. It consists of a long row of thatched huts on the beach. Each thatched hut is a hotel room. In about their middle is a larger thatched hut which is the dining room, reading room, and recreation get-together place when there is some social activity. They gave me the hut on the very end after I explained to them that I would be running my putt-putt all during the night and I did not want to keep anyone awake with its noise. This putt-putt I had was one of those very loud ones with a very small muffler which did not do to much muffling. Things on the beach in front of my room were very interesting, especially after sundown. On the nights of the full moon they have a real ball on the beach there with a lots of capers going on practically all night all up and down the beach and under the palm trees that lined the beach. That beach is a very busy place on these full moon nights. There are very few recreational activities around the island but they find plenty to do after sundown, especially on full moon nights. Well you know how it is when a bunch of boys and girls get together, they will find something to do. If there is any chaperoning down there I never saw or heard of them. Oh yes, the rates of the hotel when I was down there was only $22.00 per week and this included room and board. The food is very fine, and no one ever complained about anything there. If you want to go on a very fine vacation I highly recommend that you go to the Seychelles. I have a lots more to tell you all next month. . . . Gus

Bruce Walther W9QAH

ID Key

This is a key designed for use on front panel key jacks to either tune up or identify on RTTY. Construction is very simple and uses parts from almost any junk box.

Obtain an old surplus PL55 plug. Remove the cover and grind off the ring and about half of the bottom shell up to the ground screw.

Find an old telephone relay contact about three inches long. Drill a hole at one end to fit the tip screw on the jack. Then screw the contact in place.

Drill out the old ground screw threads and tap with a 6/32 tap. Then thread in a 6/32 screw to about 1/32 inch from the contact installed above. Cut off the remaining part of the screw and solder to the shell. Also cut the control armature to the desired length and place several wrappings of tape on the end as a knob.

Now cut a half inch slot in the cover as shown. Place the cover on the plug and align the slot on the right with contact armature.

And there you have a real space saver for the no-CW operator to load or ID with. All you have to do to lock it up is shove the contact armature to the right into the slot.

. . . W9QAH

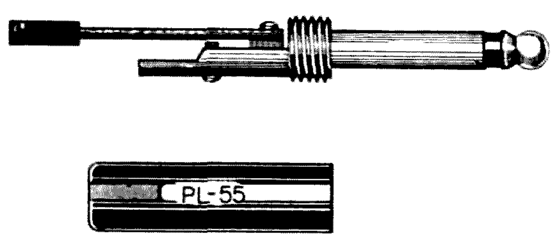


Fig. 1. The ID key.

Souping Up the Heath Twoer

Anyone who has ever purchased a Heath Twoer knows that it is a very good buy for the money. It has enough power for local contacts with the average antenna, as well as plenty of audio to fill the carrier. This article will show how to convert a good rig into a better one.

A stock set has approximately 25 ma at 200 volts going into the 6BA8 final. This can be increased to 7.5 watts with audio to match by simply changing a few resistors and capacitors. Unfortunately, this exceeds the dissipation of the final tube, but the 6BA8 seems to stand it. The difference in output is about 2 db, just discernable.

Start with the power supply. The 330 ohm 2 watt resistor R14 should be decreased to 270 ohms. You can add another electrolytic in parallel with C33A (40 µf) if you wish, but the extra filtering doesn't seem to be really necessary.

Next is the final, V4B. Decreasing the value of the screen resistor (R7) will give more power input. I found that 1000 ohms gave 7.5 watts input.

Now in the audio section, replace R23 (270,000 ohms) connected to pin 7 of V1A with a 27,000 ohm resistor. Also replace C35 (.01 µf) going from pin 6 of the 12AX7 (V1) to pin 1 of the 6AQ5 modulator (V2) with a .001 µf capacitor.

This completes the modifications and now a very slight touch up should be given the rig. As a last comment, I would suggest replacing the 6BA8 (V4) with a 6AU8—it seems to handle the extra power a little better.

. . . WB2JOS

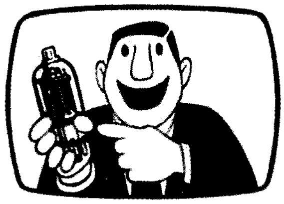
Ear Saver

Inexpensive magnetic headphones have been on the market for years; but not dirt cheap ear cushions. Dozens of suggestions have appeared in just about every electronics magazine. However, a simple and dirt cheap solution has been found. For about two bits, you can make your phones feel like the stereophones being sold for $25.00.

A trip to your local drug store will reveal that a pair of milady's "powder puffs" solve the problem easily. These "puffs" are used as replacements for lady's compacts, but they do a better job on your ears. Just cut a small hole in the middle of each "puff," glue them on the phones, and you're in business.

This kink has been in use here for more than a year and no earaches have been encountered.

. . . D. Hausman



NEW PRODUCTS

New Sams Books

Sams has been busy publishing new books again and here's a quick run-down on a few of them: John Lenk's *Eliminating Engine Interference* has 128 pages and costs $2.50. The title is pretty self-explanatory. *Basic Piezoelectricity* by John Potter Shields covers this more-and-more important field that furnishes many industrial transducers as well as the common "crystal" mikes, headphones and phonograph pick-ups. It's also 128 pages and $2.50. *Color TV Troubles Clues, Volume II* by the PF Reporter Staff is $1.95. *Electronic Corrosion Control for Boats* is by John Lenk and also costs $1.95. A very simple, easy-to-understand book for newcomers to radio is *ABC's of Modern Radio* by Walter Salm. It's been newly revised by the author and costs $1.95. All of these books are available from your local distributor or from Howard Sams Co., 4300 West 62nd Street, Indianapolis, Indiana.

Communications Electronics Circuits

An excellent new textbook for electronics technicians has just been published (3/14) by Holt, Rinehart and Winston. It's *Communications Electronics Circuits* by J. J. DeFrance. But don't let that "textbook" scare you. It's one of the best books for learning electronics I've seen. It's modern and up-to-date, explains the material very well, and gives excellent review questions for the reader's guidance in checking himself. This book is unusually good for hams who want to learn more electronics, whether for getting an extra class license or commercial license, or just for their own knowledge, since it covers many topics that are passed over lightly by most other eelctronics books: SSB, antennas, transmission lines, propagation, etc. It also integrates semiconductors into the discussion of circuits so that they aren't suddenly thrown at you in a last minute addition. Necessary and important design and illustrative math is included, but not too many derivations of formulas—so beloved by mathematicians and confusing to technical students. All in all, it's an excellent book and highly recommended. 550 pages, $9.50. Holt, Rinehart and Winston, 383 Madison Avenue, New York, N.Y. 10017.

Fair Radio Catalog

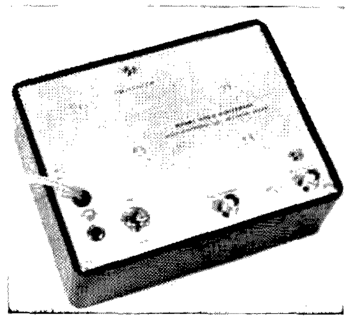
The new Fair Radio Spring and Summer Catalog contains 28 well-illustrated pages chock full of fascinating surplus bargains. Each page contains many items and virtually all are illustrated. They have a very large assortment of motors, transformers, and meters as well as many, many pieces of communications, test and other electronic equipment. This catalog is a must for any hams who aren't AO's. Send 25¢ for it (well worth the small price) and they'll refund 50¢ on your first order. Write Dept. 73, Fair Radio Sales, P.O. Box 1105, Lima, Ohio 45802.

Motorola Circuits Manual

A useful handbook put out by Motorola is their Semiconductor Circuits Manual for $2. Its main interest is power circuits: motor controls, inverters, power supplies and regulators, SCR switching controls, lamp controls, solid state ignition systems, etc. Many of these are very useful to hams and used by them every time they turn on their mobile rig or experiment with transistors. But probably the most interesting part of the book to most hams is the long section on transmitters. Theory and specs, including coil data and design considerations are given for marine band xmtrs (good for 160 and 80), CB (for 10), 30 mc SSB, 76 mc, 120 mc (AM), 2 watts on 160 mc, 5 watts and 8 watts on 240 mc. Binding is Motorola handbook's standard, easy-to-use looseleaf. Your Motorola distributor has copies, or you can order from Motorola TIC, Box 955, Phoenix, Arizona 85001.

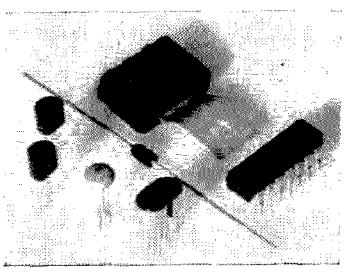
Motorola Application Note Index

The new Motorola Application note Index (April 1966) lists all of the current Motorola application notes with a small abstract of each. A fantastic number are of interest to hams (and engineers, of course) such as Designing Low Noise RF Input Transistor Stages, Low Cost Power Inverters (DC-to-DC) Using Off-the-Shelf Components, High Power Varactor Theory and Application, Transistors in SSB Amplifiers, Solid State Marine Xmtrs, Coax Cavity Varactor Multipliers, High Power RF Switching Can Replace Coax Relays, 40 watt Solid State Xmtr for 6, 5 watts on 3 GHz with Varactors, Epicap Tuning Theory, FET's in Theory and Practice, 15 watts on 2 and many more. Write Motorola TIC, Box 955, Phoenix, Arizona 85001 for your copy of the index.



Parks Solid State 432 Converter

Loren Parks K7AAD makes some of the nicest VHF and UHF gear around and is well-known by all VHF'ers for his gear and his little magazine, the *VHF'er*. He and W6HPH have recently come up with a new 432 MHz converter that is all solid state. It uses the fabulous TI TIXM05 transistors (see April issue) for extremely low noise figure and high gain. Tuned lines in the converter are all silver-plated and all components and construction are of Parks' usual high quality. Each converter is individually checked for noise figure, too. He makes them in many *if*'s and the price is right: $49.95, postpaid. You can order from him at Parks Labs, Rt. 2, Box 35, Beaverton, Oregon.



Economy TI Semiconductors

Texas Instruments has recently introduced a wide range of new economy, plastic-encased semiconductors. Among them are the industry's first plastic-encased unijunction transistor, the TIS43 with very low leakage and a very low price—72¢ in 100-quantities. Another is the TIS34, N-channel VHF field effect transistor (see the May issue of 73, page 12) with low feedback capacitance, high transconductance, high figure of merit and low cross modulation. Other interesting ones are a number of regular transistors such as the NPN 2N4254-5 for VHF and HF amplifiers, and the low-cost TIXM10 and 11 for rf amplifiers, mixers, oscillators and *if* amplifiers. You can get more information from TI distributors or Texas Instruments, P.O. Box 5012, Dallas, Texas.

(Continued from page 2)

ernments so that an official complaint can be sent through channels. The more countries we get involved in this business the better chance of it being effective, obviously. The ARRL and RSGB have been working along this line and have been achieving some results with it. It would be nice if we could organize something a little more worldly than this and try to have complaints filed from a dozen or two countries. Perhaps some amateur with a good signal and the time to devote to such a project could establish a net frequency and time for intruder watching and thus international coordination might result. Something on the order of the YL SSB "net" on 14,331 is what I have in mind . . . only without all that phone patching.

Although intentional jamming of signals is against the regulations just about everywhere there are a growing number of amateurs who are organizing this type of intruder defense. This certainly is a move to be considered even if it must remain sub rosa and might be a natural development of the above suggested net. Fortunately our work on 20 meters is not all that difficult for we have but a few intruders there most of the time. On the lower bands we have a formidable task.

While RTTY stations may be difficult to identify for us, even for those with ham RTTY gear, we do know that a well placed CW signal on either of the FSK channels can, if it overrides the intruder now and then on selective fades, cause misprinting. Most RTTY stations cannot abide misprinting on these circuits and will obligingly move to a clearer channel . . . hopefully outside our amateur bands.

Short wave broadcast stations are a bit harder to cope with. Here we may find that we will get beter results through correspondence with the broadcasters direct. I doubt if angry letters asking them to move will get more than chuckles, but sincere letters from SWLs asking them to move out from under all that amateur radio interference so they can better hear the interesting programs they are broadcasting might do the trick. The tourist agencies are also sensitive to pressure from that great benefactor: the American tourist.

While some of the commercial stations operating in the lower bands in Europe and Asia may be legitimate, we here in the U.S. have no mandate to protect them from interference. We may transmit as we like without worrying that we may be causing interference to a legitimate user of these frequencies and thus cause him to seek less crowded regions.

The only good reason that intruders are using our bands is that we are leaving space for them. There are plenty of other spots for them to operate if we nudge. Let's encourage them to find them.

ITU—Africa

Those of you who have been active on our DX bands know that there is virtually no African amateur radio activity other than by whites, visiting or residential. Since the countries are being taken over by blacks it is unlikely that a white activity will rate much protection from the new governments.

Certainly we must do something to get some support for amateur radio from these new nations. For that matter, it may actually be easier to get support from these countries than from the European countries where amateur radio seems to have a rather minimal support. Not that we are doing any better in the U.S. One of the basic reasons that I founded the Institute of Amateur Radio was to work toward getting the support of our Congress so that at future ITU conferences we would know that at least the U.S. government was solidly behind us. In 1959 I was flabbergasted to find that we did not have this support. The U.S. delegation has by far the most influence at this conference and if we don't have it supporting and protecting us to the best of its ability we might as well start work on those moon bounce dishes right now. I have been quite disappointed, though not surprised, at the bitter opposition the League has shown the Institute even though the Institute is organized to carry on work that the League has so far avoided.

To be blunt about the African problem: we don't know what to do there. It would be valuable to somehow set up some amateur radio stations there and train some locals to operate them and start them on the path to becoming devoted amateurs. Unfortunately there are many obstacles. We do have a good idea that we can arouse some interest in amateur radio by the time tested method of PR with articles in the local papers. It is possible that a donated club station plus a few newspaper articles might get things started if we had our own little Peace Corps operation with a team of two or three amateurs spending several months on the project. However, before we go plunging into something like this I think it would be valuable to send a man or two down there on a fact finding tour to see first hand what the problems are and what kind of reception we might get there to such an effort.

Did I hear someone asking how much all this is going to cost? There are always nega-

tive thinkers who try to spoil the fun. They should cut it out. I don't think financing of this would be difficult at all. In preliminary talks with a few of the amateurs in the U.S. that I know to be really seriously interested in helping to keep amateur radio going I had offers of large amounts of money and all the equipment we could possibly use. I think we could round up $50,000 easily and maybe even twice that without even asking for a dollar of that 100G the League earmarked for just such projects, but seems reluctant to actually spend.

There is a possibility that our little scheme could be coordinated with the existing Peace Corps, but I'm not sure that things might go smoother if we made every effort to include European and Asian amateurs in the task force and soft pedalled ourselves. We seem to have gotten a bit of a reputation and people often want to see what we have in the other hand when we are "giving" them something.

One of the projects that I had hoped the Institute would be able to tackle was the selling of the virtues of amateur radio to the European countries. Though amateur radio is an old story in those countries I believe that we have had as little PR there as we have in the U.S. and thus have the same lack of support we find at home. Unfortunately the Institute is growing much too slowly for me to look for any help from this quarter in the forseeable future.

The major question is: what do we do next? I don't feel that it is my place to elect myself a committee of one to start all this going. And other than myself what do we have in the way of international organization? The IARU seems hopelessly tied to the ARRL apron strings and ham strung as a result. They are bogged down in a morass of official inertia. The ARRL is on top and even if Region I of the Union wanted to break away and start something going, they would probably all be eyeing each other suspiciously to see who was trying to take advantage of the move. It would be a great step ahead if the presidents of the amateur radio societies of the world could get together in Geneva several times a year for a top level amateur radio summit conference behind closed doors and have the support of their organizations to make decisions binding at these meetings. I think that such an arrangement might make it possible to save ham radio.

W2NSD/SM/OHø/OH2

Having heard considerable about the beauty of Sweden's girls, country and socialism, I thought that I'd better check it all for myself.

The amateurs in Stockholm were very hospitable when I arrived this spring. Arne SM5AM and Beo SM5LK saw to it that I got to visit many of the active amateurs in the area. Those that I didn't visit (and most of those I did) turned out for a meeting at the Technical Museum where we ate sandwiches, drank beer and listened to me talk far into the night.

In addition to the ham radio side of my visit I did check into the three topics first mentioned. Just before the end of my stay in Stockholm (two weeks), when I thought that I was going to manage to get away without ever meeting one single girl, I found myself having dinner with Peter SM5CZM, his attractive wife and a girl friend of hers. The girl, Eva, was a good looking blond, though I must admit that I was just slightly put off by the enormous German Shepherd Dog that guarded her. Every time I thought of making a pass at her he growled. Hmmm. She didn't really need him though for I found that this lovely should have been on What's My Line. She gently rippled her muscles as she explained that she drives one of those gigantic trucks that they have only in Europe . . . you know, the ones with the huge trailer hooked on behind. Anybody that can heft one of those around could break me in two . . . I think. I didn't check.

The Swedes vigorously deny all those delightful rumors we have heard in the States about their girls. Unfortunately, after an admittedly short visit, I tend to believe the Swedes more than the smart PR men who have built the interesting Swedish girl image for us. Alas, another dream shot down.

Whenever we get to grumbling too much about the creep of socialism in the states we are answered that it works just fine in Sweden so stop complaining. Tell that to the Swedes. I didn't find one single Swede that liked the system. They are very vocal on the subject. All in all their country is very much like the U.S. It is much more like it than any other country I have visited. Their salaries are quite comparable to ours and their costs of food and other things aren't all that different. The only major difference is that they have to pay almost double the taxes we do. I suspect that our administration is aware of this and may be using the Swedish norm as a goal for us. This does limit the possibility for outstanding success in Sweden and I found most of the people a lot more concerned with their summer houses than how to make an extra crown or two.

Arne went with me for a short trip up to Aland Islands to visit the OHØ gang. He had

been wanting to make the trip for a long time and this was the excuse he was waiting for. I had bought a Volvo so we drove in it up to a small town 60 miles or so north of Stockholm to get the boat to Aland. The boat left late at night and arrived bright and early at 4:30 AM, just as the sun was really getting going for the day. Despite the grim hour of arrival we were met by Sigge OHØNI and driven the 20 miles to Marieham (town). After a short nap we got up and had an enormous breakfast. We then drove out into the country and visited OHØNF, one of the most active amateurs in Aland. We talked, took some pictures and were served coffee and cake by XYL. It was delicious, but a little close onto breakfast. They had some special Aland Island cake that I had to try. After a short visit with OHØNJ and NC we returned to NI's for a truly magnificent lunch. Urp. Just when I thought I had outdone myself they came up with special Aland Island brew which I had to try. Invented by the vikings, I believe . . . and excellent . . . urp. OK, time to go over to visit Sam NC and talk with all the active OHØ gang which was gathered there. I talked for about an hour and then we had coffee and cake. There was just time to drive out to the boat landing and wave goodbye. A short while after the boat had shoved off for Sweden Arne grabbed my arm and lead me into the restaurant. I protested that I was too full, but he said it would only be a snack. He didn't communicate this too well to the waitress though for she came in with a huge plate of food. It looked like someone with big eyes had gone by a smorgasbord table. It took me quite a while to down it all, but somehow I managed. Then she brought the main course.

A nice gang turned out to welcome me in Norrköpping and Gothemberg. The drive down was fascinating. Much of the part of Sweden I passed through sure looked a lot like our own Minnesota. Now I know why we have that tremendous Swedish population up there . . . it is just like home in looks and climate.

Finland turned out to be as expensive as Sweden for visitors. John Velamo OH2YV dropped everything for the two days of my visit and did a fine job of entertaining me. I got on the air from OH2A, OH2AA, and OH2TH, including a contact with my home station and the latest news from there. I had been in Finland for several minutes before John wanted to know if I had ever been in a sauna. His eyes lighted up fiendishly when I admitted that though I'd heard a lot about them I had never been initiated. OH2SS was selected to show me the ropes.

We reported into a clubhouse type of affair out on a point on a lake. We were issued a small orange towel and a locker for our clothes. Clad only in myself I was ushered into a small dark wooden room that felt like an oven. The towel was not for modesty, it was to sit on to keep from burning the flesh. The thermometer read a little over 120°. It felt warmer than that. Ooops, that is centigrade. It was getting a little hard to think in all that heat, but I slowly worked out the conversion to Farenheit and got 250°. They didn't have a fork so I wasn't sure how you could tell when you were done. After about 20 minutes SS led what was left of me out of the room, out the door, onto the dock and into the water which was under 40°, the ice having just melted a few days before. I agreed that it sure felt good, but I lied. OK, back into the oven for another bout. Baked ham Basted in my own juice. Then back out on that dock and into the ice water. Oh yes, it feels wonderful. Now we try to smoke room. 250° also, with nice smelling mullberry smoke. Smoked ham. Those mullberry switches don't hurt, just tingle a bit when you flaggelate yourself with them. They smell good mixed with the delightful aroma of yourself cooking.

This time instead of going out into the lake we lay down on tables and very sturdy Finnish women scrubbed us thoroughly from hair to toes using nice rough pads something like Brillo. I haven't been that clean in years.

Now that I've tried it I'll have to check into that sauna they have right near Peterborough. Our lakes are warmer, that's for sure. Besides, I'm only half baked now.

. . . Wayne

Coaxial Transmission Line Handbook

Jim Fisk WA6BSO

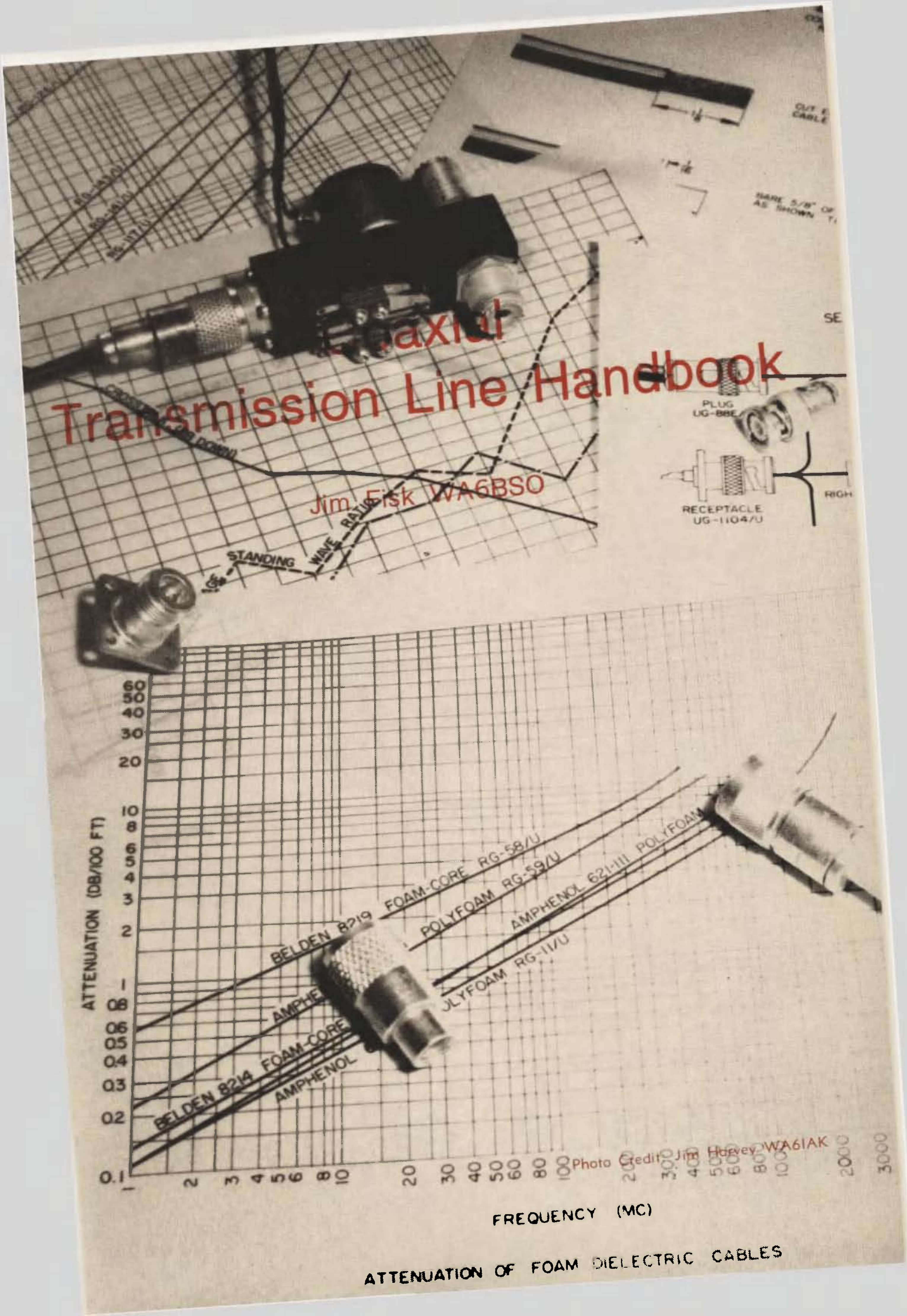


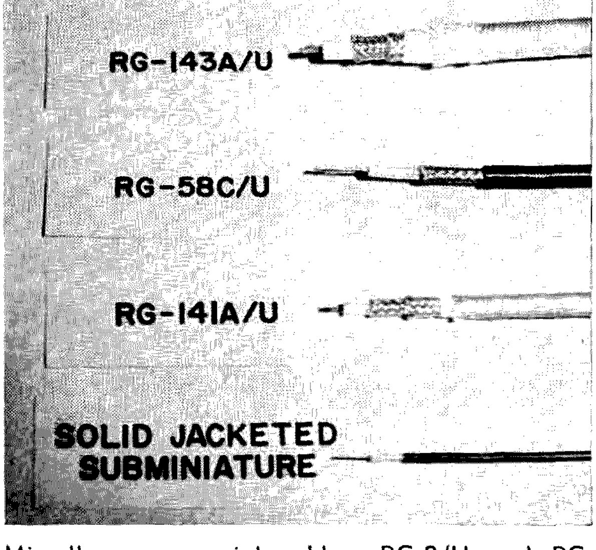
Photo Credit: Jim Harvey WA6IAK

Introduction

The coaxial cable is the simplest, most versatile and most popular means for the transmission of rf energy. However, it would be safe to say that to most amateurs coax means simply RG-8/U or RG-11/U. This is due, at least in part, to their availability and low cost. However, these familiar cables are not always the best choice for an amateur antenna system. Actually, the case of only one cable being able to satisfy a set of requirements is rare; usually there are several cables which will meet most of the requirements of a particular application. Nonetheless, the data which is published for these cables is, in some aspects, quite confusing and easily misunderstood.

Undoubtedly, more transmitted power is lost by the inadequate selection and improper use of transmission lines than from any other source. It is the purpose of this handbook to define and present the necessary data to enable the average amateur to more accurately evaluate and select a coaxial system suitable for the intended operating conditions.

It is interesting to note that the concentric form of transmission line is old—in fact, classical. Although the flexible types of solid dielectric coax available today are the products of modern materials and engineering, Lord Rayleigh, Alexander Russell, and other prominent mathematical physicists of the 19th century did considerable theoretical work with the coaxial structure before the turn of the century.



Miscellaneous coaxial cables: RG-8/U and RG-58C/U are polyethylene types; RG-143A/U and RG-141A/U are Teflon types with Fiberglas jackets; and solid jacketed cables are semiflexible types.

The earliest types of coaxial line were limited to telephone transmission lines and submarine cables. However, in the early 1930's engineers at the Bell Telephone Laboratories experimented with coaxial lines for the transmission of high-frequency radio energy. The rigid air-spaced lines used in these experiments only vaguely resembled the flexible lines in common use today, but it must be remembered that polyethylene wasn't discovered until 1937 or available in commercial quantities until 1943; and Teflon* wasn't even announced until 1946. These early cables were constructed using ceramic disks or beads spaced at intervals along the line to support the inner conductor. Since the outer conductor was fabricated from rigid copper tubing, these experimental coaxial lines were far from flexible, but they proved to be very efficient in high-frequency rf transmission.

Prior to World War II the rigid disk insulated concentric line saw little use in all but the most sophisticated commercial installations. In the late 1930's a few manufacturers advertised rubber insulated flexible coaxial cable, but because of the high cost and attenuation characteristics, these lines were not popular among amateurs. Since relatively few television stations were on the air at this time, the extra shielding afforded by coaxial lines were not a necessity for TVI elimination.

With the advent of an inexpensive low-loss flexible dielectric during the war years, thousands of feet of low cost coaxial cable became available on the surplus market in 1946. Unfortunately, the majority of amateur transmitters of the day were not suitable for the inherently unbalanced coaxial system. It wasn't until the impact of TVI that the coaxial transmission line became the mainstay of amateur transmission systems.

Because of the rapid advances made in transmission line technology during the war, a committee was set up to determine industry-wide standards for coaxial cables, connectors and adapters and to establish a universal numbering system. The familiar "RG"-/U, derived from "radio guide," was designated for rf transmission lines, both coaxial and waveguide. The "UG"-/U system, derived from "union guide," was assigned to rf connectors and adapters used with these lines. The suffix "U" was used to indicate a "universal" system of numbering.

*Trademark of Dupont

Table 1. Comparison of coaxial cable characteristics.

Cable Type		RG-8/U	Aljak	Aljak	Foam-Flex	Styroflex	Helical Membrane	Corr-O-Foam	Rigid
Dielectric		Poly-ethylene	Poly-ethylene	Teflon	Foamed Poly-ethylene	Poly-styrene Tape	Poly-ethylene Ribbon	Foamed Poly-ethylene	Air
Outer Conductor		Copper Braid	Aluminum	Aluminum	Aluminum	Aluminum	Aluminum	Corrugated Aluminum	Copper
Outside Dimension (Inches)		0.405	0.325	0.325	0.5C0	0.500	0.500	0.570	0.875
Weight (lb/100 ft)		10.5	6.9	10.3	15.2	16.5	18.5	15.0	65.0
Minimum Bend Radius (Inches)		2.1	1.8	1.8	5.0	5.0	6.0	5.0	0
Maximum Operating Temperature (F°)		185	185	390	185	185	185	185	—
Capacity (pf/ft)		29.5	31.5	29.5	25.0	23.0	21.0	25.0	—
Peak Operating Voltage		5000	5000	5000	2500	1300	1300	2500	—
Attenuation (db/100 ft)	10 mc	0.55	0.33	0.55	0.25	0.25	0.24	0.25	0.13
	00 mc	2.00	1.50	1.80	0.86	0.80	0.76	0.85	0.41
	1000 mc	8.00	7.60	6.20	3.31	2.80	2.47	3.30	1.60
Average Power (Watts)	10 mc	3490	3700	17000	12600	7700	5800	7600	17000
	100 mc	1000	1000	5200	3800	2400	1600	2300	4600
	1000 mc	240	300	1500	1000	720	560	610	1400

All coaxial cables consist of the same basic elements: a center conductor, a dielectric and an outer conductor followed by a waterproof jacket. Where extreme environments may be encountered, an outside armor or lead sheath may be used.

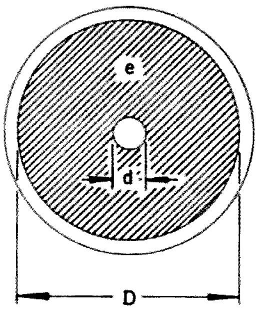
Coaxial cables are available in three main configurations; braided flexible cable, semi-flexible cable and rigid line. The braided cable consists of a solid or stranded inner conductor, solid dielectric, braided outer conductor and a protective plastic outer jacket. This cable is noted for its flexibility but suffers from higher losses than the other two types.

Semiflexible cable is constructed with a solid or tubular inner conductor, a helical or foamed or solid dielectric and a tubular metal outer conductor. This cable may be bent during initial installation but cannot withstand constant flexing.

Rigid lines are usually made from precision hard-drawn brass or copper tubing but extruded aluminum or copper-clad stainless steel have been used to a limited extent. The center conductor is rigidly supported by some type of dielectric bead or rod, mechanically crimped or swaged between the conductors. These lines exhibit low attenuation and high power handling ability and have long been the mainstay of commercial broadcasting. They also find extensive use in television broadcasting and commercial communications at frequencies where waveguide is too bulky.

Flexible coaxial cables

In flexible coaxial lines, solid or stranded copper wire is normally used for the center conductor of the cable. In some cases copper covered steel conductors are used to add mechanical strength to the smaller cable sizes.



e = DIELECTRIC CONSTANT

$$Z_0 = \frac{138}{\sqrt{e}} \log_{10} \frac{D}{d}$$

Fig. 1. Coaxial Structure.

Silver plating is applied to prevent oxidation of the copper when the cable is used at elevated temperatures. Tin plating is used to facilitate soldering to connectors; however, the use of tinned conductors should be limited to low-frequency applications where the thickness of the plating will not significantly increase cable attenuation.

A polyethylene dielectric is used almost exclusively where the maximum temperature will not exceed 185 degrees Fahrenheit. The use of Teflon (Polytetrafluoroethylene) is required when temperatures from 185 to 500 degrees are encountered in the vicinity of the dielectric.

As a rule, the outer conductor consists of a close fitting braid of fine copper wire. A number of fine wires are combined to form a carrier comparable to a single flat reed in a woven basket; these carriers are woven in and out to form the braid. To avoid excessive radiation loss and to insure proper shielding, approximately 99% braid coverage is required. This coverage is determined by the stranding of the carrier, the number of carriers and the "lay" of the braid. The lay is defined as that length of cable required for the carrier to make one complete revolution around it and determines ultimate cable flexibility. Tin- or silver-plated strands are used for the same reason as for the inner conductor, as well as the apparent rf resistance of the braid. Occasionally, a second braid of either copper or steel is used to improve the shielding properties of the cable. The second shield has only a minimum effect upon attenuation and is designed primarily for improved flexibility and shielding.

The jacketing material generally used with polyethylene cables is composed of black vinyl resins extruded over the outer conductor. There are two types of vinyl which are used for jacketing purposes: regular vinyl and noncontaminating vinyl. Because polyethylene has a chemical affinity for some of the plasticizers used in the regular vinyl jacket, the development of the noncontaminating type was undertaken. Although the dissipation factor of nearly all dielectric materials except Teflon increases with age due to natural oxidation, the use of a noncontaminating jacket limits deterioration in cable performance. Since the rate of aging is temperature dependent, the use of cables with the noncontaminating jackets is especially important where the cables will be subjected to elevated temperatures.

The graph of **Fig. 2** compares the attenuation of two samples of coaxial cables, one with a contaminating jacket (RG-8/U) and the other with a noncontaminating jacket (RG-8A/U), to the number of days at a temperature of 200 degrees Fahrenheit. After 160 days, the attenuation of the cable with the contaminating jacket at 3000 megacycles increased nearly four times while the attenuation of the cable with the noncontaminating vinyl jacket increased only 0.01 db per foot at the same frequency. It must be emphasized that while this 200 degree test simply accelerated the aging process, normal aging will cause the same effect at a slower rate.

The useful life of cables jacketed with the contaminating type of vinyl is in the neighborhood of three to seven years. Beyond this point the attenuation increases exponentially and reaches very high values. On the other hand, cables with noncontaminating jackets offer life expectancies well in excess of fifteen years. Considering that their extra cost only runs about a penny a foot, the noncontaminating types of cables are a good investment.

Some polyethylene cables are jacketed with high molecular weight carbon-black loaded

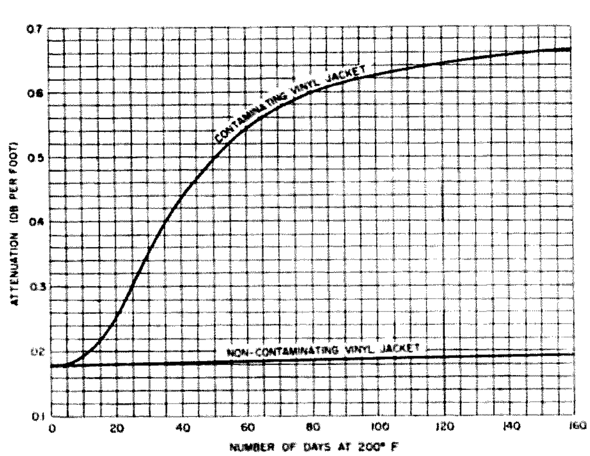


Fig. 2. Effect of contaminating jacket on cable attenuation.

polyethylene. These jackets contain no plasticizers whatsoever and offer life expectancies well in excess of twenty-five years. In addition, they are ten times less permeable to moisture than the vinyl jackets.

Teflon insulated coaxial cables are jacketed with slightly different materials. Because of the higher temperature characteristics of the Teflon dielectric, it is desirable that the jacket also exhibit these same properties. For this reason, Teflon cables are usually jacketed with a close wrap of Teflon tape, followed by one or more fiber glass braids impregnated with silicon varnish.

A relative new addition to the family of flexible cables is the foamed dielectric version. These cables were designed to satisfy the requirements for a low attenuation, low capacity, lightweight, flexible r-f cable. The dielectric consists of cellular polyethylene, foamed with an inert gas to produce completely enclosed cells within the polyethylene. Amphenol Polyfoam and Belden Foam-Core cables are of this type.

Compared to a standard RG-/U cable of equivalent size, the attenuation of foam dielectric cables is reduced by as much as 35%. This is particularly desirable where long cable runs are required or for VHF and UHF applications.

Semiflexible coaxial cables

There are many constructonal variations between the extremes of rigid coaxial lines and flexible cables which fall into the category of solid-jacketed or semiflexible cables. These cables have a number of outstanding characteristics for a wide variety of applications. Their electrical advantages over the standard RG-/U type flexible cable are lower attenuation and minimum signal radiation or pickup. Mechanically, they are somewhat lighter in weight than flexible cables and have the advantage of small size and complete weatherproofing.

Instead of the conventional braid shield and vinyl jacket, the outer conductor of these cables is a seamless or corrugated ductile metal tube. Aluminum is most often used for such applications because of its lighter weight and lower cost than copper, but both steel and copper have been used to a limited extent. These cables may be formed into moderate bends during installation and in some applications protective coverings may be added for greater abrasion or corrosion resistance.

Since the seamless outer conductor prevents contamination of the dielectric material, nearly unlimited operating life may be expected. Also,

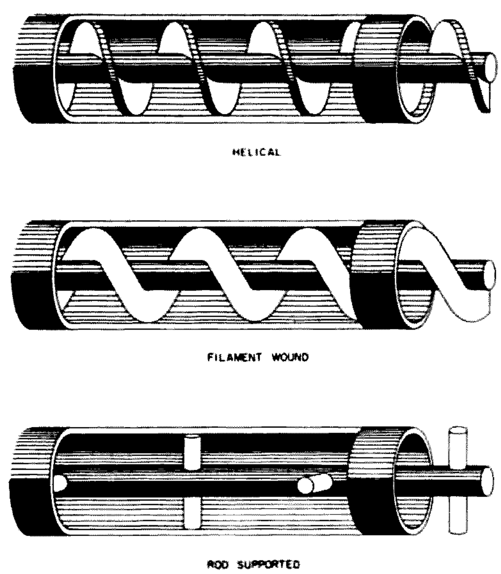


Fig. 3. Special types of coaxial cable.

the seamless outer conductor allows negligible energy radiation. Because of the lower losses associated with semiflexible cables, it is possible to use a smaller size cable to obtain loss figures equivalent to a braided cable system.

The dielectric used in semiflexible lines may be either an airspaced structure or some form of solid dielectric. In the former, a continuous or rod of dielectric material is spirally wound around the center conductor to support it as shown in **Fig. 3.** Styroflex* cables are manufactured with a continuous laminated helix composed of thin flexible polystyrene tape; this tape is a unique form of polystyrene, characterized by excellent electrical and mechanical properties. No plasticizer is needed to achieve flexibility because this property is obtained by means of special manufacturing processes. The laminated type of construction has a great deal of strength and permits the finished cable to withstand heavy crushing loads. These lines are available in both 50 and 70 ohm versions in many different sizes from $\frac{3}{8}$ to $6\frac{1}{8}$ inches in diameter.

Another type of helical construction which is popular consists of a flat ribbon of polyethylene or Teflon helically wound around the inner conductor. This ribbon is made by machining a spiral from a hollow dielectric tube and drawing an aluminum sheath tightly over the open spiral. This type of construction results in less attenation than the laminated helix, but is not as strong. Also, greater care must be taken during installation to insure that the center conductor does not shift be-

*** Trademark of Phelps Dodge Electronic Products Corporation**

cause of cable bends or thermal expansion. Helical Membrane* cables are of this type.

Heliax* * is a special variety of helical construction that uses a thick polyethylene ribbon to support the inner conductor. The outer conductor is a length of corrugated steel tubing, copper plated on the inside for improved conductivity. The cable is protected on the outside with weatherproofing compound, impregnated paper tape and a vinyl jacket. The main advantage of this construction is the ability of the outer conductor to withstand repeated flexure (50 to 200 times) without failure. Also, no special straightening or bending tools are required during installation.

For smaller size cables, sufficient strength is obtained with a spirally wound filament of Teflon or polyethylene at a much lower cost. Spirafil* cable is an example of this type manufacture.

The second type of semiflexible cable uses a solid dielectric. Recent cables of this type use polyethylene or Teflon dielectric (Amphenol's Aljak) or foamed polyethylene (Phelps Dodge Foamflex) with an aluminum sheath. The use of solid dielectric increases the peak operating voltage and the attenuation, but maintains the equivalent power handling capacity of air-spaced lines.

Foamed polyethylene insulation offers a practical form of a homogenous air-filled dielectric which retains its normal dielectric strength without pressurization. The reduction of dielectric constant, compared with solid polyethylene, results in lower attenuation.

Semiflexible coaxial lines provide a compact, rugged installation, with mechanical protection equivalent to lightweight conduit for permanent installations in cable raceways, along bulkheads or similar applications. Close contact with metallic supporting structures greatly enhances their heat dissipating properties. Other advantages over conventional braid cables are low attenuation, no radiation,

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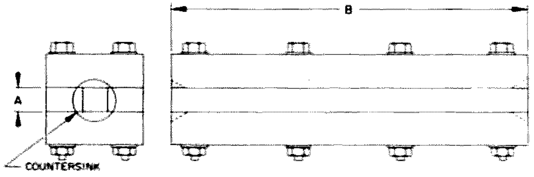
**Trademark of Andrews Corporation



NOMINAL CABLE DIAMETER	DIMENSION "A" (SQUARE)	DIMENSION "B"
5/16"	21/64"	8-1/8"
3/8"	25/64"	9-3/8"
1/2"	33/64"	12-1/2"
3/4"	25/32"	18-3/4"
1"	1-1/32"	25"
1-1/8"	1-5/32"	28-1/8"
1-5/8"	1-11/16"	40-5/8"

Fig. 4. Semiflexible cable straightener.

high phase stability, uniform electrical characteristics over wide temperature variations, and unlimited operating life.

The main disadvantage of solid-jacketed semiflexible cables (other than those with foamed dielectric) is that all newly installed air dielectric cables must be purged and then pressurized with either dry nitrogen or dehydrated air before being placed into operation. This is to insure that the cable is and remains dry. The use of nitrogen gas is generally preferred over dehydrated air in purging and pressurizing relatively small and medium sized cable systems.

Semiflexible coaxial cables are becoming increasingly popular, particularly in those applications requiring critical impedance, maximum shielding or noise-suppression requirements. Although they have seen little use as yet in amateur applications, it is expected that they will become popular in the UHF region where waveguide is prohibitively large and expensive.

Although it is difficult to make an accurate comparison between flexible, semiflexible and rigid lines because of the difference in diameters, **Table 1** lists some of the more common cables with their respective characteristics.

If care and the proper tools are used during the installation of these cables, sharp bends and kinks can be avoided and the cables may be reused. Precautions should be taken to prevent continued vibration or flexing from "work hardening" and eventually cracking the sheath. From this standpoint, copper is less susceptible to work hardening than is aluminum.

The semiflexible cables are received from the manufacturer in a coil and it is usually necessary to straighten it before use. A simple straightening device consists of a close fitting wooden box as shown in **Fig. 4.** The recommended box length and cable cutout for the common sizes of semiflexible cable are given in the illustration. This box may be constructed from any standard knot-free wood of suitable dimensions. The box entrances should be countersinked as shown and a small amount of mineral oil applied to minimize friction.

Threading the box onto the larger cables, particularly one inch in diameter and larger is facilitated by using bolts. In this case, the top of the box is opened slightly to allow insertion of the cable and then is cinched down with the bolts. For smaller cables this is usually not necessary and the box may be put together with common wood screws.

Most manufacturers furnish semiflexible coaxial cable in 1000 or 5000 foot lengths, but Phelps Dodge has special kits of ½ inch, 50 ohm Foamflex with connectors for amateur applications. These kits are available in 50 or

100 foot lengths with connector, cable clamps, pressure-sensitive tape and seven foot length of flexible RG-8A/U jumper included. For applications where direct burial of the cable is desired, this cable is available with a special Habirlene jacket at a slightly higher cost. Although the non-jacketed version costs 50¢ per foot, the nearly unlimited operating life offered by this type coax seems to outweigh the disadvantage of its higher cost over conventional braided transmission lines.

Coaxial cable characteristics

There are six basic coaxial cable parameters for which values are normally published. These are:

1) Characteristic Impedance
2) Attenuation
3) Capacitance
4) Velocity Factor
5) Power Rating
6) Maximum Operating Voltage

The first four characteristics are critically dependent upon the dimensional variations of the cable and are carefully regulated during the manufacturing process. The last two parameters are considerably less affected by any dimensional variations, but are rather functions of the overall dimensions and type of coaxial cable. In addition, impedance, capacitance, attenuation, and velocity factor are all interrelated, while the voltage rating and power rating are pretty much independent of each other.

Impedance

The characteristic impedance of the cable is undoubtedly the most discussed and most used parameter. This quantity is directly proportional to the dimensions of the conductors and the dielectric constant of the insulating material as shown in **Fig. 5.** It is interesting

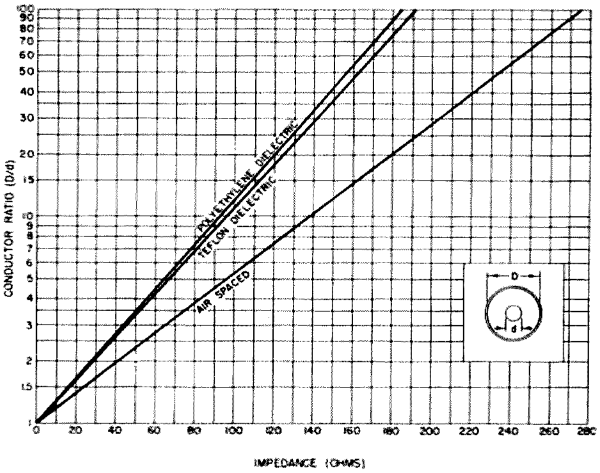


Fig. 5. Characteristic impedance of coaxial cables.

to note that the dimensions of the conductors in a coaxial line may be selected for minimum attenuation, maximum power or maximum voltage rating. Sadly enough, the dimensions for optimizing each of these characteristics are not the same; corresponding impedance values for optimizing each of the characteristics are listed in **Table 2.**

Table 2. Comparison of optimum diameter ratios and impedances for coaxial lines.

Condition	D/d	Characteristic Impedance (Ohms)		
		Air Dielectric	Polyethylene Dielectric	Teflon Dielectric
Minimum Attenuation	3.59	76.6	51.0	52.9
Maximum Voltage	2.72	60.0	39.9	41.4
Maximum Power	1.65	30.0	20.0	20.7

Fortunately, moderate departures from these optimum values do not introduce rapid changes in the electrical characteristics of the line. For this reason, three impedance levels are generally accepted as reasonable compromises between the infinite number of possible values:

- 50 ±2 ohms Preferred for VHF and UHF applications, test equipment, and transitions between coaxial line and waveguide.
- 75 ±3 ohms High-frequency use to 30 mc, very long cable runs.
- 95 ±5 ohms Low capacitance, twin conductor cables.

Generally speaking, the uniformity of the characteristic impedance has a greater effect on circuit performance than the absolute value of the impedance chosen. The larger center conductor of the 50-ohm line results in a stronger physical structure and a more uniform line. Also, 50-ohm lines facilitate the design of coaxial connectors with excellent impedance matching characteristics.

Attenuation

As a signal proceeds from the transmitter along the line to the antenna, the signal will decrease in magnitude because of cable attenuation. The attenuation in coaxial cable is made up of two kinds of losses; series losses in

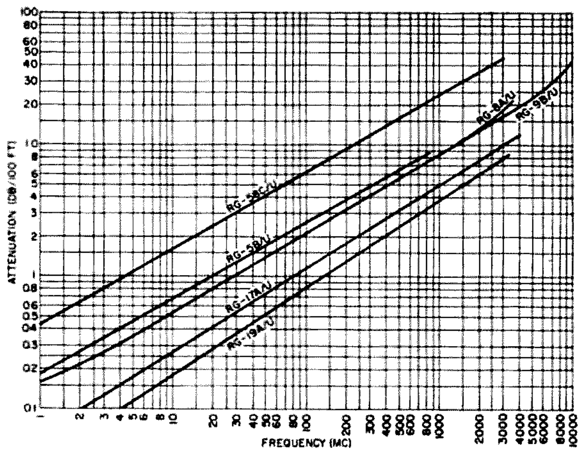


Fig. 6. Attenuation of polyethylene cables.

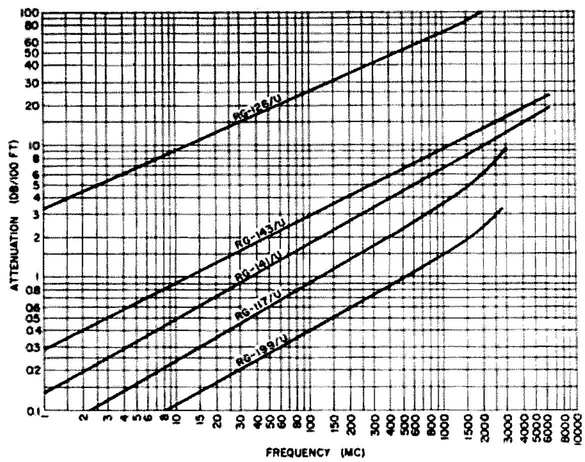


Fig. 7. Attenuation of Teflon cables.

the center and outer conductors, and shunt losses in the dielectric. The series losses are proportional to the square root of the frequency and constitute the major portion of the cable's attenuation. Shunt losses are caused by the conductivity of the dielectric material and are directly proportional to frequency. Attenuation measurements at 100 mc indicate that the conductor losses are about six times greater at this frequency than the dielectric losses. On the other hand, at 10,000 mc, the dielectric losses are about twice as great as the conductor losses.

The losses associated with the conductors are considerably increased when stranded conductors are utilized. For instance, a braided outer conductor will multiply the losses over a solid outer conductor by two or three times. This is because the rf currents in a coaxial line are always in the direction of propagation. At the lower frequencies the currents tend to follow the individual braid wires spirally around the cable. At high frequencies however, the currents move in a straight line from strand to strand, dissipating energy in contact resistance. Therefore, a braid having a long lay will have less attenuation than one having a short lay. Mechanical considerations limit the lay of the braid however and greater stability with flexing may be attained with a shorter lay. The tightness with which the braid is woven is also important in eliminating instability under flexing and in decreasing contact resistance between braid wires. Since a loose or open braid, or any form of surface contamination, may cause erratic attenuation when the cable is flexed, it is important that the individual braid wires are not embedded in the dielectric or jacketing material. The braid signed for increased stability at UHF frequencies.

Attenuation curves for the more commonly used coaxial cables are plotted versus frequency in **Figs. 6** through **9** respectively for polyethylene, Teflon, foamed and semiflexible lines. The attenuation curves plotted in these graphs are based on an operating temperature of 68° Fahrenheit, and for accurate calculations at other temperatures, the attenuation must be scaled according to the graph of **Fig. 10.** For the climatic conditions normally found in the continental United States, the changes will amount to less than three percent, but under extreme temperatures, these changes should be considered.

When calculating the attenuation of a transmission line, the effect of any standing waves along the line must be considered if accurate results are desired. If the standing wave ratio is greater than one, line loss is multiplied because the greater effective voltages and currents along the line increase its resistive and dielectric losses. Line loss multiplication due to standing waves may be calculated from the relationship

$$\text{Line loss multiplier} = \frac{\text{SWR} + \frac{1}{\text{SWR}}}{2}$$

For convenience, line loss multipliers for standing wave ratios up to 11:1 are plotted in **Fig. 11.**

Since coaxial line attenuation is given in decibels, it is helpful to convert to power ratios to determine the effect of line attenuation on transmitted power. **Fig. 12** charts the transmitted power versus attenuation up to 10 db. If more accuracy is required, the "DB-Power, Voltage and Current Ratio Table" may be used.

Example 150 feet of RG-9B/U is used as the antenna transmission line in a 144 mc amateur installation. With an ambient temperature of 85°, standing wave ratio of 2.6:1 and transmitter output power of 580

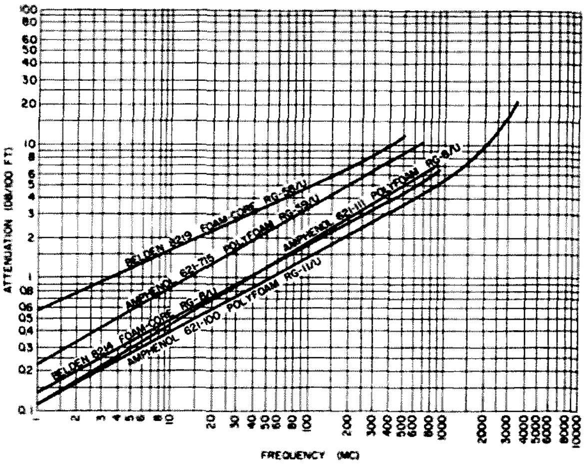


Fig. 8. Attenuation of foam dielectric cables.

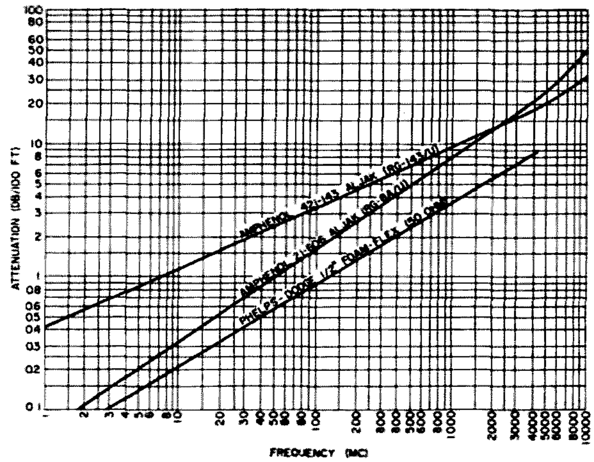


Fig. 9. Attenuation of solid jacketed cables.

watts, what is the total attenuation of the line and how much power will be transmitted to the antenna?

From Fig. 6, the attenuation of RG-9B/U at 144 mc is 2.7 db per 100 feet. The attenuation per 150 feet then may be found from

$$\text{Loss (db)} = \frac{L\ (db_{100})}{100}$$

Where L = Length of transmission line in feet
db_{100} = Attenuation of line per 100 feet in db

In this case,

$$\text{Loss (db)} = \frac{150 \times 2.7}{100} = 4.05 \text{ db}$$

This is the loss of 150 feet of RG-9B/U at 144 mc with unity SWR at 68° Fahrenheit. With an ambient temperature of 85°, the loss must be multiplied by 1.02 (see **Fig. 10**). From **Fig. 11**, an SWR of 2.6:1 corresponds to a line loss multiplier of 1.49. Under the stated operating conditions then, the total loss of the 150 foot transmission line is

$$4.05 \text{ db} \times 1.02 \times 1.49 = 6.16 \text{ db}$$

From Figure 1-12, 6.16 db corresponds to 24.2% of the transmitter power (580 watts) will be transmitted to the antenna.

$0.242 \times 580 = 139.4$ watts to the antenna

Cable capacitance

The capacitance of solid dielectric cables varies inversely with the characteristic impedance and averages from 21 to 29.5 pf per foot respectively for 75- and 50-ohm cables. It is often desirable to have lower capacitance, particularly in conjunction with high-impedance circuits where the coaxial line shunts the input to the device. To obtain lower capacitances, a very thin center conductor or an air spaced dielectric is usually provided. In any case, the characteristic impedance of low capacitance lines normally varies between 95- and 185-ohms.

Velocity factor

The velocity factor is defined as the ratio of the velocity of propagation of an rf signal in a cable to the velocity of propagation in free space. When a dielectric other than air is used as the insulating material, the propagation of the waves is slowed down by the dielectric medium in much the same way that light is slowed down (and refracted) by a glass lens. For the case of polyethylene cables the velocity factor is 0.66; for Teflon, 0.695; and for foamed cables, between 0.78 and 0.80, depending upon the manufacturer. The important consideration here is that when a length of coaxial line is being cut to some specific electrical length it must be foreshortened by the velocity factor. As an aid in designing coaxial impedance transformers, baluns, match-

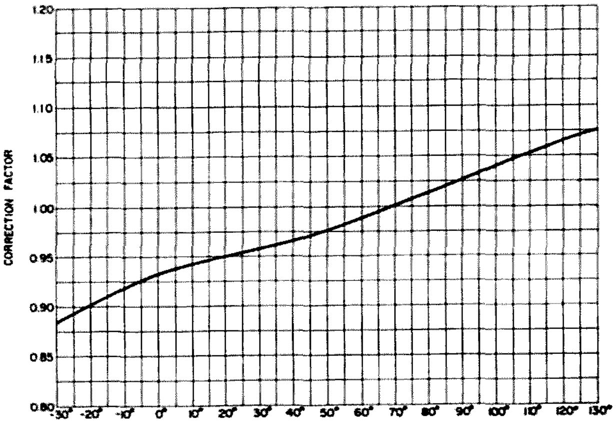


Fig. 10. Temperature correction factor for coaxial cable attenuation.

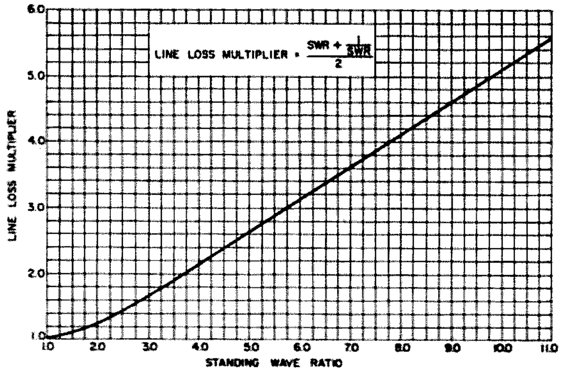


Fig. 11. Effect of SWR on line attenuation.

ing stubs, etc., the electrical wavelengths of various cables are tabulated in **Tables 4** through **8**, for the amateur bands up to 1296 mc.

Power rating

Of major importance in the selection of a coaxial cable is the ability of the cable to safely carry the anticipated power. Since most of the medium sized cables used today will safely carry a full kilowatt at the lower frequencies, this parameter is usually of little consequence to the amateur who limits his operation to 30 mc and below. However, the power rating of any coaxial cable decreases with frequency and must be considered when running high power on the VHF and UHF bands. The maximum r-f power that a coaxial line may safely transmit is limited by either (1) the voltage introduced by the peak power, or (2) the thermal heating due to the average power. Which of these factors will predominate varys with the operating conditions of the transmission line.

At operating frequencies over 10 mc the power rating of the cable resolves itself into a problem of efficient heat transfer from the coaxial cable surface to the surrounding environment and the maximum temperatures which the cable materials can withstand.

As might be expected, the voltage and power ratings increase directly with the diameters of the cable. Additionally, the amount of heat which flows radially from the line depends upon the thermal properties of the dielectric and jacket. Radio-frequency energy generates heat at the center conductor, within the dielectric and at the shield in direct proportion to the individual attenuation of each. Excessive heat can result in movement of the center conductor due to softening of the dielectric, mechanical damage due to thermal expansion and shortened life because of accelerated chemical action. Therefore, for any praticular construction, the average power rating will depend upon the permissible temperature rise above a stated ambient.

Assuming that the internal temperatures are the same, the power rating at one frequency is inversely proportional to the total attenuation at that frequency, and the power ratings at any other frequency may be determined from the following expression:

$$P_x = P_t \frac{a_x}{a_t}$$

Where: P_x = Power rating at unknown frequency
P_t = Power rating at test frequency
a_x = Attenuation at unknown frequency
a_t = Attenuation at test frequency

Using this equation, a complete set of power

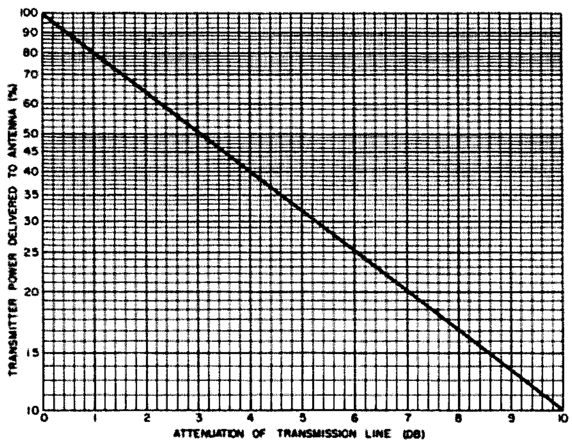


Fig. 12. DB-Power ratio.

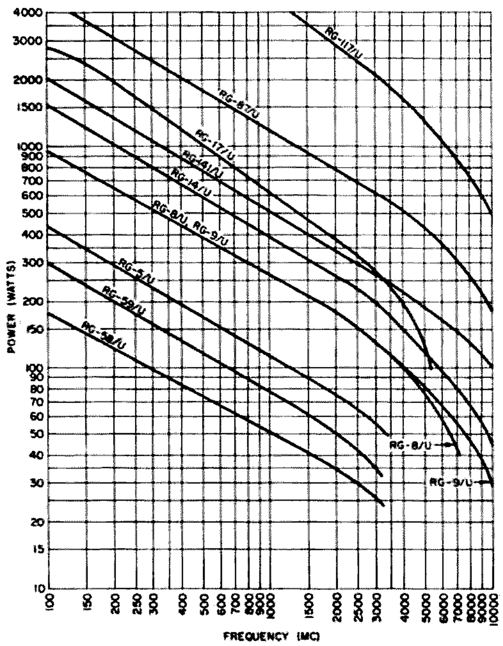


Fig. 13. Power rating of coaxial cables.

rating curves may be plotted if the attenuation curves are known. However, the power curves should not be plotted below 10 mc because electric breakdown rather than thermal limitations will govern.

Since a standing wave ratio along a transmission line multiplies the attenuation of the line, it will also decrease the power rating of the cable. This is because there are larger effective voltages and currents along a line with a standing wave ratio greater than 1:1 and hence considerable more heating of the conductors and dielectric. If it is assumed that the radial transfer of heat from the inner conductor to the atmosphere is the predominate factor, the power rating at other than unity SWR will be changed by a factor equal to the reciprocal of the new SWR; this power derating factor is plotted in **Fig. 15.**

Example If a coaxial cable has a power rating of 1000 watts at a specified frequency for an SWR of 1:1, the power rating with a SWR of 1.6:1 would be approximately 625 watts at the same frequency.

Another factor which derates the power handling capacity of the cable is the altitude. This is because as the altitude is increased above sea level, the less dense atmosphere is a less efficient heat conductor and the power rating must be decreased accordingly. This altitude derating factor is illustrated graphically in **Fig. 16.** Consequently, when considering the maximum operating power of a coaxial line, four factors must be considered: frequency, standing wave ratio, ambient temperature, and altitude.

Example Consider the hypothetical case of high power 432 mc equipment located on top of a mountain under conditions:

Altitude—5000 feet
Ambient temperature—120° Fahrenheit
Standing Wave Ratio—3:1

Assuming RG-8/U coaxial line is used, what is the maximum power that may be safely used?

Looking at the power rating curve in **Fig. 13,** at 432 mc RG-8/U will safely carry 430 watts of rf at sea level at 100 degrees Fahrenheit. Assuming that the station is 5000 feet above sea level, the power rating must be decreased by 7% as shown in **Fig. 16** to 400 watts. Since the local temperature is 120 degrees, the power must be further reduced by 28% (Polyethylene curve in **Fig. 14**) to 288 watts. In as much as the SWR is 3:1, a further reduction of 67% is required, yielding a total power capability under the stated conditions of 76 watts, more than a five to one reduction from the initial rated 430 watts.

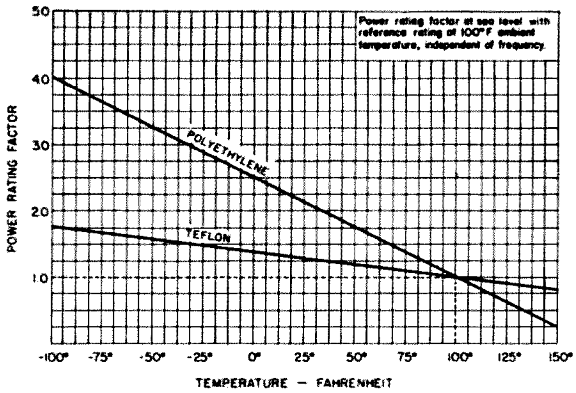


Fig. 14. Power rating factor for coaxial cables.

For higher ambient temperatures or for increased power ratings, Teflon cables are desirable. Teflon has a slightly lower high-frequency attenuation because of the lower dissipation factor, but because of their relatively high cost, Teflon cables are used only when their superior temperature characteristics or improved performance are economical.

Phase temperature characteristic

This term is of particular significance to those amateurs designing phased arrays where the phase relationship between signals traveling on different transmission lines is critical. This term is used to establish the variation in cable length with temperature. The reasons for variation are obvious when considering that all materials expand and contract with temperature. It is interesting to note that flexible braided cable is very poor in this respect, whereas a good quality semiflexible cable will change less than 15 parts per million per degree Fahrenheit.

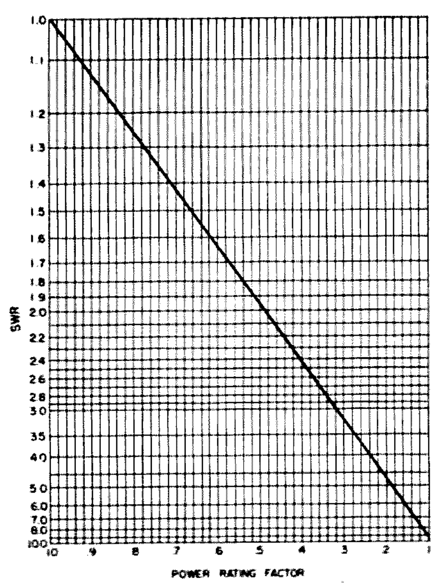


Fig. 15. Effect of SWR on power rating.

Table 3. DB power, voltage and current ratios.

DB	Power Ratio		Voltage or Current Ratio	
	Gain	Loss	Gain	Loss
0.1	1.02	.977	1.01	.989
0.2	1.05	.955	1.02	.977
0.3	1.07	.933	1.03	.966
0.4	1.10	.912	1.05	.955
0.5	1.12	.891	1.06	.944
0.6	1.15	.871	1.07	.933
0.7	1.17	.851	1.08	.923
0.8	1.20	.832	1.10	.912
0.9	1.23	.813	1.11	.902
1.0	1.26	.794	1.12	.891
1.1	1.29	.776	1.13	.881
1.2	1.32	.759	1.15	.871
1.3	1.35	.741	1.16	.861
1.4	1.38	.724	1.17	.851
1.5	1.41	.708	1.19	.841
1.6	1.44	.692	1.20	.832
1.7	1.48	.676	1.22	.822
1.8	1.51	.661	1.23	.813
1.9	1.55	.646	1.24	.803
2.0	1.58	.631	1.26	.794
2.1	1.62	.617	1.28	.781
2.2	1.66	.603	1.29	.776
2.3	1.70	.588	1.31	.763
2.4	1.74	.575	1.32	.759
2.5	1.78	.562	1.33	.752
2.6	1.82	.550	1.35	.741
2.7	1.86	.538	1.36	.735
2.8	1.90	.525	1.38	.724
2.9	1.94	.514	1.39	.716
3.0	1.99	.501	1.41	.708
3.1	2.04	.490	1.43	.699
3.2	2.09	.479	1.44	.692
3.3	2.14	.468	1.46	.684
3.4	2.19	.457	1.48	.676
3.5	2.24	.446	1.50	.667
3.6	2.29	.436	1.51	.661
3.7	2.34	.427	1.53	.654
3.8	2.40	.417	1.55	.646
3.9	2.45	.408	1.57	.638
4.0	2.51	.398	1.58	.631
4.1	2.57	.389	1.60	.625
4.2	2.63	.380	1.62	.617
4.3	2.69	.372	1.64	.610
4.4	2.75	.363	1.66	.603
4.5	2.82	.355	1.68	.596
4.6	2.88	.347	1.70	.589
4.7	2.95	.339	1.72	.582
4.8	3.02	.331	1.74	.575
4.9	3.09	.324	1.76	.568
5.0	3.16	.316	1.78	.562
5.1	3.24	.309	1.80	.556
5.2	3.31	.302	1.82	.549
5.3	3.39	.295	1.84	.543
5.4	3.47	.288	1.86	.537
5.5	3.55	.282	1.88	.531
5.6	3.63	.275	1.91	.525
5.7	3.72	.269	1.93	.519
5.8	3.80	.263	1.95	.513
5.9	3.89	.257	1.97	.507
6.0	3.98	.251	1.99	.501
6.5	4.47	.224	2.11	.473
7.0	5.01	.199	2.24	.447
7.5	5.62	.178	2.37	.422
8.0	6.31	.158	2.51	.398
8.5	7.08	.141	2.66	.376
9.0	7.94	.126	2.82	.355
9.5	8.91	.112	2.98	.335
10.0	10.00	.100	3.16	.316
11.0	12.60	.079	3.55	.282
12.0	15.80	.063	3.98	.251
13.0	19.9	.050	4.47	.224
14.0	25.1	.040	5.01	.199
15.0	31.6	.032	5.62	.178
16.0	39.8	.025	6.31	.158
17.0	50.1	.020	7.08	.141
18.0	63.1	.016	7.94	.126
19.0	79.4	.013	8.91	.112
20.0	100.0	.010	10.00	.100
21.0	125.9	.008	11.22	.089
22.0	158.5	.006	12.59	.079
23.0	199.6	.005	14.13	.071
24.0	251.2	.004	15.85	.063
25.0	316.2	.003	17.80	.056
30.0	1000.0	.001	31.62	.032
35.0	3162.0	.0003	56.24	.018
40.0	10000	.0001	100.00	.010
45.0	31620	.00003	177.80	.006
50.0	10^5	10^{-5}	316.23	.003
55.0	—	—	562.40	.0017
60.0	10^6	10^{-6}	1000.0	.001

Shielding properties

Although it is generally accepted that the coaxial line offers a completely shielded method for rf transmission, this is not necessarily so. Interference and crosstalk can appear between a coaxial line and surrounding equipment due to the radiation of energy through the braid. Although insignificant at the lower frequencies, it can become quite troublesome in the UHF region. This radiation through the shield is attenuated in two ways; absorption by the shield material and reflection due to the impedance discontinuities

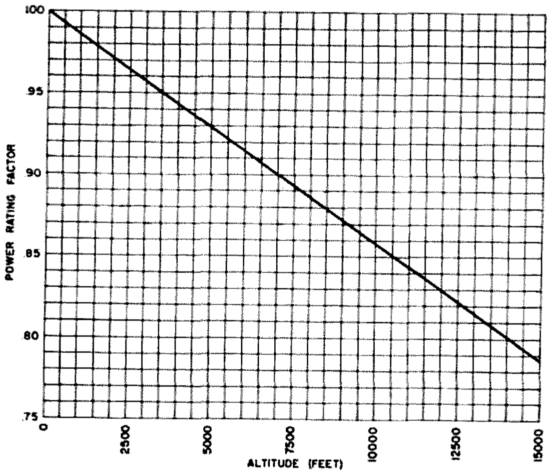


Fig. 16. Effect of altitude on power rating.

where the individual strands of the braid cross one another.

Frequently, the reflection loss from the irregularities of the braid material is greater than the attenuation through the braid. Also, if the braid is constructed from two different materials, the greater the reflections and the more effective the shielding. For instance, the use of copper and steel as a double braid forms a very effective low-frequency shield. Even greater shielding may be obtained by alternately interweaving layers of conductor and insulating materials and this "triaxial" technique is often used in the manufacture of high voltage pulse cables.

Cable standing wave ratio

In the UHF region, the standing wave ratio of a properly terminated flexible coaxial cable may vary between 1.1 and 1.3, occasionally reaching sharp peaks of 1.6 to 1.8. This is because flexible cables exhibit bad resonances at certain frequencies. These resonances are caused by periodic variations in the diameter of the dielectric. Small variations are inherent in the nature of the mechanical extrusion process and are more prevalent in Teflon than in polyethylene. From the standpoint of transmission line theory, gradual variations in cable diameters would cause little reflection. However, abrupt discontinuities in the line that are repeated periodically add up to a very large mismatch at the input end of a long cable at those frequencies for which the discontinuities are spaced by an even number of half cycles.

Cutoff frequency

Although it is not widely appreciated, coaxial cables do have an upper frequency limit. This so-called cutoff frequency is defined as that frequency at which the rf energy within the coaxial structure does not propagate in the proper mode; that is, the frequency at which the line acts more like a piece of waveguide than a piece of coax.

The cutoff frequency is reached when the mean diameter of the coax becomes equal to one wavelength. Practical experience indicates that coax should not be used beyond about 95% of this value because of the extremely abrupt increase in attenuation. This frequency is defined by the following relation:

$$F_c\ (\text{mc}) = \frac{7520}{(d + D)\sqrt{e}}$$

Where: F_c = Cutoff frequency
d = Outside diameter of inner conductor
D = Inside diameter of outer conductor
e = Dielectric constant of insulating material

The cutoff frequency should be of little consequence to the majority of amateur applications since it falls well above 10,000 mc for all but the large diameter cables. It should be noted that the attenuation curves should not be projected into the cutoff region because of the rapid change in slope.

Special cables

In addition to the common types of coaxial line with which most amateurs are familiar, there are several special cables that should be mentioned briefly. One of these is the high attenuation type designed specifically for attenuation pads and loads in instrumentation applications. In order to achieve high attenuation, RG-21/U and RG-126/U use a high resistance number 16 AWG Nichrome wire for the center conductor. Since the majority of attenuation is in the center conductor, the attenuation of these lines is roughly proportional to the square root of the frequency. These cables replace the older RG-38/U attenuating cable which used a lossy rubber dielectric as the attenuating element. In RG-38/U, the attenuation is nearly proportional to frequency.

Subminiature cables which do not have standard RG-/U designations are seeing extensive use in transistorized equipment where size and weight are at a premium. Cables of this type are available in both flexible and semiflexible versions with Teflon, polyethylene and foam dielectrics.

Triaxial cables are available which exhibit very good shielding properties at frequencies up to 10 mc. Although intended primarily for pulse service, they may be used in other applications where noise is a problem.

Table 9. Equivalent international coaxial cables.

USA	British	French	Swedish	Russian
RG-8/U	Uniradio No. 67	KX50MD1	HK-50-7	PK-47
RG-11/U	Uniradio No. 57*	KX76MD1	—	PK-20*
RG-17/U	Uniradio No. 74	—	HK-50-17	—
RG-58/U	Uniradio No. 43	—	HK-50A-3	—
RG-58A/U	Uniradio No. 76	—	HK-50B-3	—
RG-63/U	Uniradio No. 64	—	—	—
RG-133/U	Uniradio No. 78	KX100MM1	—	—

*Similar to but not equivalent

Several manufacturers have special "low-noise" coaxial cables which remain electrically neutral under conditions of shock and vibration. Spurious signals may be generated by standard flexible cable under conditions of extreme flexure; these signals may well be of a higher level than the useful signal being transmitted along the line. The reduction of this inherent noise is obtained by applying a semi-conductive coating between the dielectric and the outer braid.

Although other countries do not have the convenience of coaxial cable standardization that the United States does, most of them have cables that are equivalent or similar to standard RG-/U types. **Table 9** lists British, French, Swedish and Russian coaxial cables and their RG-/U counterparts.

Coaxial cable testing

Accurate testing of coaxial transmission lines normally requires sophisticated laboratory equipment, but some rather simple tests that may be made in the ham shack are useful in determining the quality of a particular coaxial cable in use.

The easiest test is that of isolation between the inner and outer conductors. For this test a 500 volt megohmeter should be used. For good, high quality, unterminated coaxial cable, the isolation between the conductors should be at least 100,000 megohms. If the isolation is less than this, the attenuation of the line will be extremely high, the power rating will be limited and early failure may occur due to voltage breakdown or excessive heat.

Impedance measurement

Another test that is simple to perform, and that is more indicative of cable quality is measurement of the characteristic impedance of the line. For new, high quality coaxial cable, the characteristic impedance should be within one or two percent of that specified by the manufacturer. For example, a 50 ohm line should have a characteristic impedance between 49 and 51 ohms. If the measured impedance is more than two percent off, it is indicative of serious faults within the line. Poor manufacturing processes, contaminated dielectric, and moisture and dirt all contribute to the degradation of cable impedance.

This test is easy to perform and requires only a grid-dip meter and an accurate capacitance bridge or Q-meter. First of all, one end of the cable to be tested is short-circuited with a piece of wire. The grid-dipper is then coupled to the other end of the line and tuned for a dip. Resonant points will be obtained at several different frequencies, but the one lowest in frequency is the one used in this measurement.

Next, remove the short and measure the capacity of the line with the capacitance bridge or Q-meter. For this measurement, several readings should be made and then averaged for best results. Using the capacity of the line and the lowest frequency of resonance, the characteristic impedance of the line may be calculated from the following formula.

$$Z_o = \frac{2.5 \times 10^5}{fC}$$

Where Z_o = Characteristic impedance of the line
f = Lowest frequency of resonance in mc
C = Capacity in picofarads

Example: A length of coaxial cable has a measured capacity of 1377 pf and the lowest frequency of resonance in 3.65 mc.
What is its characteristic impedance?

$$Z_o = \frac{2.5 \times 10^5}{(3.65\ \text{mc})\ (1377\ \text{pf})} = 49.74\ \text{ohms}$$

Attenuation measurement

The most direct method for measuring attenuation is to measure and compare voltages at the beginning and end of a properly terminated transmission line. A vacuum tube voltmeter may be used for this purpose at frequencies up to about 30 mc, but at higher frequencies the two voltage measurements are more difficult to make and a more accurate method should be used. For frequencies up to about 200 mc, a Q-Meter may be used with rather accurate results. The Q-meter is simply a series-resonant circuit with a variable oscillator and a device for indicating the peak voltage or Q across the variable capacitor at resonance.

To use this method of attenuation measurement, the line to be tested is attached to the Q-meter as shown in **Fig. 17**; a shorting switch is shown in the illustration, but any method of shorting the cable will do; a flat piece of copper sheet is excellent for this purpose. The Q-meter is then adjusted to the resonant frequency of the open circuited line; when the line is shorted, the Q-meter should indicate series resonance at the same frequency. If not, a small frequency adjustment may be made to compensate for end effect and other stray effects which cause slight changes in resonance.

Note the relative reading of the voltage indicator on the Q-meter with the line open-circuited and remove the cable from the meter. Substitute standard composition resistors across the Q-meter terminals until the same relative meter reading is obtained. When the equivalent parallel resonant resistance of the cable is determined, the attenuation of the line may be calculated from:

$$a = \frac{8.69\ Z_o}{R_e}$$

Where: a = Attenuation in db
Z_o = Characteristic impedance of the line in ohms
R_e = Equivalent resonant resistance of the line

Since this procedure is not dependent upon the actual values read on the Q-meter and the variable capacitor dial, better accuracy is obtained. This is because even the most expensive Q-meters are rather inaccurate at VHF

Table 4. Free space wavelength.

Frequency (mc)	λ	λ/2	λ/4
3.50	281′ 0.27″	140′ 6.13″	70′ 3.07″
3.75	262′ 3.45″	131′ 1.73″	65′ 6.87″
4.00	245′ 10.73″	122′ 11.37″	61′ 5.69″
7.00	140′ 6.13″	70′ 3.07″	35′ 1.53″
7.15	137′ 6.76″	68′ 9.38″	34′ 4.69″
7.30	134′ 8.84″	67′ 4.42″	33′ 8.21″
14.00	70′ 3.07″	35′ 1.53″	17′ 6.77″
14.20	69′ 3.19″	34′ 7.60″	17′ 3.80″
14.35	68′ 6.50″	34′ 3.25″	17′ 1.63″
21.00	46′ 10.04″	23′ 5.02″	11′ 8.51″
21.25	46′ 3.43″	23′ 1.72″	11′ 6.86″
21.45	45′ 10.25″	22′ 11.13″	11′ 5.57″
28.00	35′ 1.53″	17′ 6.77″	8′ 9.38″
28.50	34′ 6.14″	17′ 3.07″	8′ 7.54″
29.00	33′ 11.00″	16′ 11.50″	8′ 5.75″
29.70	33′ 1.44″	16′ 6.72″	8′ 3.36″
50.0	236.06″	118.03″	59.02″
51.0	231.43″	115.72″	57.86″
52.0	226.98″	113.49″	56.75″
53.0	222.70″	111.35″	55.68″
54.0	218.57″	109.29″	54.64″
144.0	81.97″	40.98″	20.49″
145.0	81.40″	40.70″	20.35″
146.0	80.84″	40.42″	20.21″
147.0	80.29″	40.15″	20.07″
148.0	79.75″	39.88″	19.99″
220.0	53.65″	26.83″	13.41″
222.5	53.05″	26.52″	13.26″
225.0	52.46″	26.23″	13.12″
420.0	28.10″	14.05″	7.03″
425.0	27.77″	13.89″	6.94″
432.0	27.32″	13.66″	6.83″
440.0	26.83″	13.41″	6.71″
450.0	26.23″	13.12″	6.56″
1215.0	9.71″	4.86″	2.43″
1225.0	9.64″	4.82″	2.41″
1250.0	9.44″	4.72″	2.36″
1275.0	9.26″	4.63″	2.32″
1296.0	9.11″	4.55″	2.28″

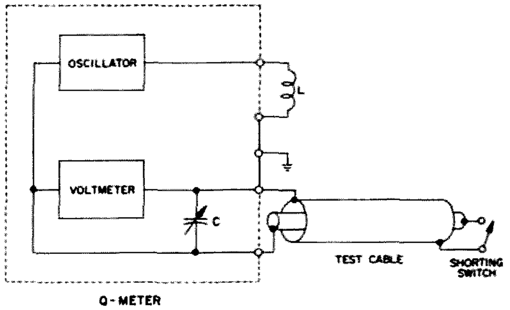


Fig. 17. Test setup for measuring coaxial cable attenuation.

Table 5. Coaxial cable wavelength. Polystyrene dielectric. Velocity of propagation = 0.66.

Frequency (mc)	λ	λ/2	λ/4
3.50	185′ 5.70″	92′ 8.85″	46′ 4.42″
3.75	173′ 1.32″	86′ 6.66″	43′ 3.33″
4.00	162′ 3.48″	81′ 1.74″	40′ 6.87″
7.00	92′ 8.85″	46′ 4.42″	23′ 2.21″
7.15	90′ 9.50″	45′ 4.75″	22′ 8.38″
7.30	88′ 11.11″	44′ 5.56″	22′ 2.78″
14.00	46′ 4.42″	23′ 2.21″	11′ 7.11″
14.20	45′ 8.59″	22′ 10.29″	11′ 5.15″
14.35	45′ 2.85″	22′ 7.43″	11′ 3.71″
21.00	30′ 10.95″	15′ 5.48″	7′ 8.74″
21.25	30′ 6.59″	15′ 3.29″	7′ 7.65″
21.45	30′ 3.17″	15′ 1.58″	7′ 6.79″
28.00	23′ 2.21″	11′ 7.11″	5′ 9.55″
28.50	22′ 9.33″	11′ 4.67″	5′ 8.33″
29.00	22′ 4.62″	11′ 2.31″	5′ 7.15″
29.70	21′ 10.31″	10′ 11.16″	5′ 5.58″
50.0	155.80″	77.81″	38.91″
51.0	152.74″	76.37″	38.19″
52.0	149.81″	74.90″	37.45″
53.0	146.98″	73.49″	36.75″
54.0	144.26″	72.13″	36.06″
144.0	54.10″	27.05″	13.52″
145.0	53.72″	26.86″	13.43″
146.0	53.36″	26.68″	13.34″
147.0	52.99″	26.50″	13.25″
148.0	52.64″	26.32″	13.16″
220.0	35.41″	17.71″	8.85″
222.5	35.01″	17.51″	8.75″
225.0	34.62″	17.31″	8.66″
420.0	18.55″	9.27″	4.64″
425.0	18.33″	9.17″	4.58″
432.0	18.03″	9.02″	4.51″
440.0	17.71″	8.85″	4.43″
450.0	17.31″	8.66″	4.33″
1215.0	6.41″	3.21″	1.60″
1225.0	6.36″	3.18″	1.59″
1250.0	6.23″	3.12″	1.56″
1275.0	6.11″	3.06″	1.53″
1296.0	6.01″	3.00″	1.50″

Table 6. Coaxial cable wavelength. Teflon dielectric. Velocity of propagation = 0.695.

Frequency (mc)	λ	λ/2	λ/4
3.50	195′ 3.73″	97′ 7.86″	48′ 9.93″
3.75	182′ 3.48″	91′ 1.74″	45′ 6.87″
4.00	170′ 10.76″	85′ 5.38″	42′ 8.69″
7.00	97′ 7.86″	48′ 9.93″	24′ 4.97″
7.15	95′ 7.28″	47′ 9.64″	23′ 10.82″
7.30	93′ 7.70″	46′ 9.85″	21′ 3.93″
14.00	48′ 9.93″	24′ 4.97″	12′ 2.49″
14.20	48′ 1.68″	24′ 0.84″	12′ 0.42″
14.35	47′ 7.64″	23′ 9.82″	11′ 10.91″
21.00	32′ 6.62″	16′ 3.31″	7′ 3.66″
21.25	32′ 2.25″	16′ 1.01″	7′ 2.51″
21.45	31′ 10.41″	15′ 11.21″	7′ 1.61″
28.00	24′ 4.97″	12′ 2.49″	6′ 1.25″
28.50	23′ 11.83″	11′ 11.91″	5′ 11.96″
29.00	23′ 6.86″	11′ 9.43″	5′ 10.72″
29.70	23′ 0.22″	11′ 6.11″	5′ 9.06″
50.0	164.06″	82.03″	41.02″
51.0	160.84″	80.42″	40.21″
52.0	157.75″	78.88″	39.44″
53.0	154.77″	77.39″	38.69″
54.0	151.91″	75.96″	37.98″
144.0	56.97″	28.48″	14.24″
145.0	56.57″	28.29″	14.14″
146.0	56.19″	28.09″	14.05″
147.0	55.80″	27.90″	13.95″
148.0	55.43″	27.71″	13.86″
220.0	37.29″	18.64″	9.32″
222.5	36.87″	18.43″	9.22″
225.0	36.46″	18.23″	9.11″
420.0	19.53″	9.77″	4.89″
425.0	19.30″	9.65″	4.83″
432.0	18.99″	9.50″	4.75″
440.0	18.64″	9.32″	4.66″
450.0	18.23″	9.12″	4.56″
1215.0	6.75″	3.38″	1.69″
1225.0	6.67″	3.34″	1.67″
1250.0	6.56″	3.28″	1.64″
1275.0	6.43″	3.22″	1.61″
1296.0	6.33″	3.16″	1.58″

frequencies. On the other hand, tests have shown that standard composition resistors exhibit constant resistance from DC to about 200 mc and the comparison method yields precision of about 5 percent for 50 ohm coaxial cables.

Example: What is the attenuation of a 50 ohm coaxial cable with an equivalent parallel resonant resistance of 91 ohms?

$$a = \frac{8.69 \times 50}{91} = 4.8 \text{ db attenuation}$$

Time domain reflectometry

In military and commercial installations, the time domain reflectometry technique is used to determine the performance of coaxial cable systems. Although this system in its commercial form is much too sophisticated for most amateur installations, it should be mentioned in passing. This technique uses pulse-echo measurements to locate points of impedance change along a coaxial transmission line and has been referred to as a "closed loop" radar system. Here a fast rising voltage pulse is repetitively fed into the transmission line under

Table 7. Coaxial cable wavelength. Amphenol polyfoam dielectric. Velocity of propagation = 0.80.

Frequency (mc)	λ	λ/2	λ/4
3.50	224′ 9.82″	112′ 4.91″	56′ 2.46″
3.75	209′ 9.96″	104′ 10.98″	52′ 5.49″
4.00	196′ 8.58″	98′ 4.29″	49′ 2.15″
7.00	112′ 4.90″	56′ 2.45″	28′ 1.23″
7.15	110′ 0.61″	55′ 0.31″	27′ 6.15″
7.30	107′ 9.47″	53′ 10.74″	26′ 11.37″
14.00	56′ 2.45″	28′ 1.23″	14′ 0.61″
14.20	55′ 4.95″	27′ 8.48″	13′ 10.24″
14.35	54′ 10.00″	27′ 5.00″	13′ 8.51″
21.00	37′ 5.64″	18′ 8.87″	9′ 4.43″
21.25	37′ 0.35″	18′ 6.17″	9′ 3.09″
21.45	36′ 8.20″	18′ 4.10″	9′ 2.05″
28.00	28′ 1.23″	14′ 0.61″	7′ 0.31″
28.50	27′ 7.31″	13′ 9.66″	6′ 10.83″
29.00	27′ 1.60″	13′ 6.80″	6′ 9.40″
29.70	26′ 5.95″	13′ 2.98″	6′ 7.49″
50.0	188.85″	94.42″	47.21″
51.0	185.14″	92.57″	46.29″
52.0	181.58″	90.79″	45.40″
53.0	178.16″	89.08″	44.54″
54.0	174.86″	87.43″	43.71″
144.0	65.57″	32.79″	16.39″
145.0	65.12″	32.56″	16.28″
146.0	64.67″	32.34″	16.17″
147.0	64.23″	32.12″	16.05″
148.0	63.80″	31.90″	15.95″
220.0	42.92″	21.46″	10.73″
222.5	42.44″	21.22″	10.61″
225.0	41.97″	20.98″	10.49″
420.0	22.48″	11.24″	5.62″
425.0	22.22″	11.11″	5.55″
432.0	21.86″	10.93″	5.46″
440.0	21.46″	10.73″	5.37″
450.0	20.98″	10.49″	5.25″
1215.0	7.77″	3.89″	1.94″
1225.0	7.71″	3.85″	1.93″
1250.0	7.55″	3.78″	1.89″
1275.0	7.41″	3.70″	1.85″
1296.0	7.29″	3.64″	1.82″

Table 8. Coaxial cable wavelength. Belden foamcore dielectric. Velocity of propagation = 0.78.

Frequency (mc)	λ	λ/2	λ/4
3.50	219′ 2.37″	109′ 7.19″	54′ 9.59″
3.75	204′ 7.01″	102′ 3.51″	51′ 1.75″
4.00	191′ 9.57″	95′ 10.59″	47′ 11.39″
7.00	109′ 7.18″	54′ 9.59″	27′ 4.80″
7.15	107′ 3.59″	53′ 7.80″	26′ 9.90″
7.30	105′ 1.14″	52′ 6.57″	26′ 3.29″
14.00	54′ 9.59″	27′ 4.80″	13′ 8.40″
14.20	54′ 0.33″	27′ 0.17″	13′ 6.08″
14.35	53′ 5.55″	26′ 8.78″	13′ 4.39″
21.00	36′ 6.39″	18′ 3.20″	9′ 1.60″
21.25	36′ 1.24″	18′ 0.62″	9′ 0.31″
21.45	35′ 9.20″	17′ 10.60″	8′ 11.30″
28.00	27′ 4.80″	13′ 8.40″	6′ 10.20″
28.50	26′ 11.03″	13′ 5.51″	6′ 8.76″
29.00	26′ 5.46″	13′ 2.73″	6′ 7.36″
29.70	25′ 10.00″	12′ 11.00″	6′ 5.50″
50.0	184.13″	92.06″	46.03″
51.0	180.52″	90.26″	45.13″
52.0	177.04″	88.52″	44.26″
53.0	173.70″	86.85″	43.43″
54.0	170.49″	85.24″	42.62″
144.0	63.93″	31.97″	15.98″
145.0	63.49″	31.75″	15.87″
146.0	63.06″	31.53″	15.76″
147.0	62.63″	31.31″	15.66″
148.0	62.21″	31.10″	15.55″
220.0	41.85″	20.92″	10.46″
222.5	41.38″	20.69″	10.34″
225.0	40.92″	20.46″	10.23″
420.0	21.92″	10.96″	5.48″
425.0	21.66″	10.83″	5.42″
432.0	21.31″	10.66″	5.33″
440.0	20.92″	10.46″	5.23″
450.0	20.46″	10.23″	5.11″
1215.0	7.58″	3.79″	1.89″
1225.0	7.52″	3.76″	1.88″
1250.0	7.37″	3.68″	1.84″
1275.0	7.22″	3.61″	1.81″
1296.0	7.10″	3.55″	1.78″

test; impedance changes along the line reflect some of the energy and the reflections are viewed on an oscilloscope. Because the pulse travels down the line at a known speed (determined by the velocity factor of the cable), impedance changes separated in space are separated in time and appear as individual "pips" on the scope. Furthermore, the shape and size of each reflection is indicative of the type of impedance discontinuity present.

This system is particularly useful in large installations where it is desirable to locate physical deformities, breaks and other injuries without complete disassembly and examination. Since this technique indicates the nature of the problem, it is possible to determine such things as impedance discontinuities caused by a tightly squeezed cable clamp or improperly installed connectors. In one case the time domain reflectometry technique showed exactly where to examine a cable in an antenna tower to find a cable injury caused by a rifle bullet. On a large ship a mismatch problem was pinpointed and upon investigation was found to be in the vicinity of steam pipes that had softened the cable dielectric.

Coaxial cable installation

In the installation and use of coaxial transmission lines, there are seven basic rules which must be followed if the most advantageous use of the line is to be realized. These are as follows:

1. Select cables well within their electrical ratings.
2. Do not specify Teflon dielectric cables unless the power ratings or ambient temperature exceeds the safe values for polyethylene.
3. Seal the ends of all cables during storage to preclude damage from moisture and dirt.
4. Do not install coaxial cable in close proximity to "hot spots" such as heat dissipating resistors or vacuum tubes.
5. Avoid bending radii less than ten times the cable diameter.
6. Use hanger straps or clamps to relieve strain on long cable runs.
7. Use the least number of coaxial connectors possible; they increase the standing wave ratio.

Long coaxial cable runs

When long horizontal cable runs are required in a particular installation, the coaxial cable should be lashed to a suspended steel-reinforced cable messenger. It is important that the proper messenger be selected on the basis of length, weight and climatic conditions. For most amateur installations where cable diameters are less than ½ inch in diameter, and where suspension lengths of 150 feet or less are required, steel-reinforced messenger cable with a tensile strength of 80,000 pounds is satisfactory. The coaxial cable is then lashed to the messenger cable with hard AWG #12 aluminum lashing wire. The easiest and most reliable method of lashing is to spirally wind the lashing wire around the coaxial cable and the messenger. Care should be taken so that the lashing is taut and pitch is uniform. When coaxial connectors must be installed along a suspended cable run, an expansion loop must be provided. This loop allows for thermal expansion and contraction, relieving axial stress on the connector, and effectively anchors the inner and outer conductor together, preventing relative motion between them.

Selecting coaxial cable

If in the selection of a coaxial transmission line the impedance, attenuation and other criteria are optimized, the maximum use of the cable will be obtained. As an aid to coaxial cable selection, **Table 10** lists all of the RG-/U cables in common use today along with their most important operating parameters. Foamed flexible cables are contained in a separate chart at the end of the RG-/U listing.

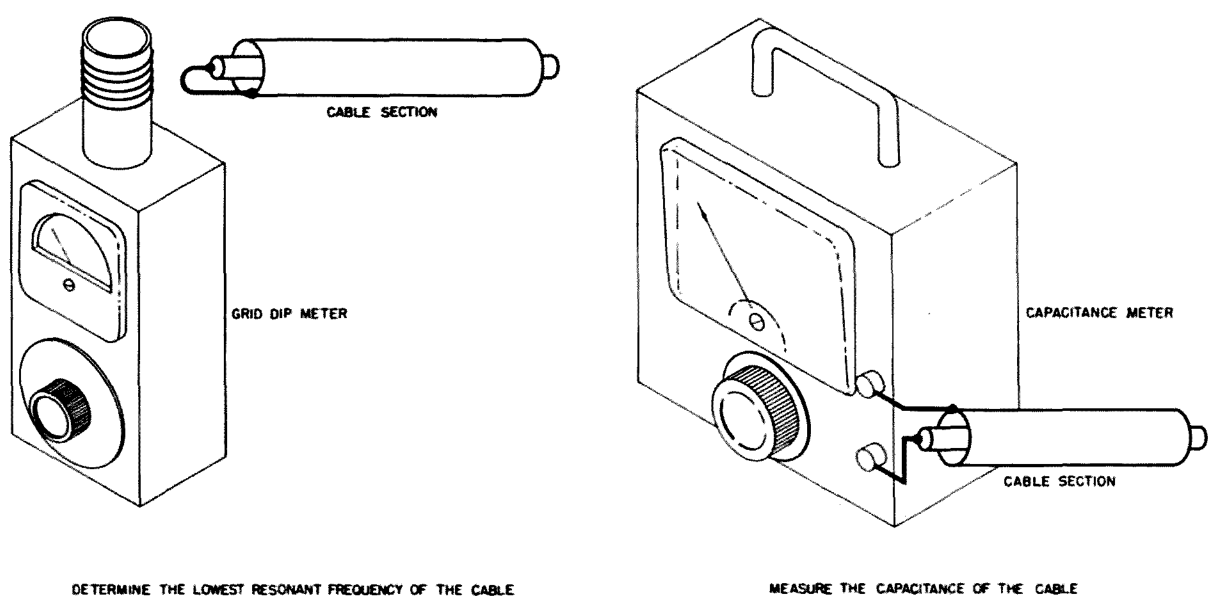


Fig. 18. Test arrangements for determining coaxial cable impedance.

Table 10. Coaxial cable characteristics.

RG/U Type	Inner Conductor		Dielectric Material	Jacket		Shield		Impedance (Ohms)	Cap. (pf/ft)	Engineering Data	Attenuation in db/100 ft		Max. Opr. Volts RMS	Max. Power Watts @ 50mc
	Mat.	Strand		Mat.	O.D.	Inner	Outer				(100 mc)	(1000 mc)		
4	C	20 AWG	A1	V	0.226	C	C	50.0	30.0	Replaced by RG-58/U	—	—	1900	300
5	C	16 AWG	A1	V	0.332	C	C	52.5	28.5		2.6	9.5	3000	600
5A	SC	16 AWG	A1	NVG	0.328	SC	SC	50.0	28.5		2.4	8.8	3000	600
5B	SC	0.051	A1	NVB	0.328	SC	SC	50.0	28.5	Now designated as RG-212/U	2.4	8.8	3000	600
6	CW	21 AWG	A1	NVG	0.332	SC	C	76.0	20.0		2.8	11.0	2700	600
6A	CW	0.0285	A1	NVB	0.332	SC	C	75.0	20.0		2.8	11.0	2700	600
7	C	19 AWG	A2	V	0.370	—	C	95.0	12.5	Replaced by RG-63B/U	2.0	7.8	1000	—
8	C	7/0.0285	A1	V	0.405	—	C	52.0	29.5		2.1	9.0	4000	1445
8A	C	7/0.0285	A1	NVB	0.405	—	C	52.0	29.5	Now designated as RG-213/U	2.1	9.0	5000	1445
9	SC	7/0.0285	A1	NVG	0.420	SC	C	51.0	30.0		2.0	8.5	4000	1445
9A	SC	7/0.0285	A1	NVG	0.420	SC	SC	51.0	30.0		2.3	8.6	4000	1445
9B	SC	7/0.0285	A1	NVB	0.420	SC	SC	50.0	30.0	Now designated as RG-214/U	2.3	8.6	5000	1445
10	C	7/0.0285	A1	NVGA	0.475	—	C	52.0	29.5		2.1	9.0	4000	1445
10A	C	7/0.0285	A1	NVGA	0.475	—	C	52.0	29.5	RG-8A/U with armor. Now designated as RG-215/U	2.1	9.0	5000	1445
11	TC	7/0.0159	A1	V	0.405	—	C	75.0	20.5		2.1	7.8	4000	1445
11A	TC	7/0.159	A1	NVB	0.405	—	C	75.0	20.5		2.1	7.8	5000	1445
12	TC	7/0.0159	A1	NVBA	0.475	—	C	75.0	20.5		2.1	7.8	4000	1445
12A	TC	7/0.0159	A1	NVBA	0.475	—	C	75.0	20.5	RG-11A/U with armor.	2.1	7.8	5000	1445
13	TC	7/0.0159	A1	V	0.420	C	C	74.0	20.5		2.1	7.8	4000	1445
13A	TC	7/0.0159	A1	NVB	0.420	C	C	74.0	20.5	Now designated as RG-216/U	2.1	7.8	5000	1445
14	C	0.102	A1	NVG	0.545	C	C	52.0	29.5		1.4	6.2	5500	1280
14A	C	0.102	A1	NVB	0.545	C	C	52.0	29.5	Now designated as RG-217/U	1.4	6.2	7000	1280
15	CW	15 AWG	A1	V	0.545	C	C	76.0	20.0		1.58	6.5	5000	1280
16	CT	0.125	A1	V	0.630	—	C	52.0	29.5		1.2	6.7	6000	—
17	C	0.188	A1	NVG	0.870	—	C	52.0	29.5		0.85	4.2	11000	7450
17A	C	0.188	A1	NVB	0.870	—	C	52.0	29.5	Now designated as RG-218/U	0.85	4.2	11000	7450
17B	—	—	—	—	—	—	—	—	—	Cancelled. Assigned new nomenclature as RG-177/U	—	—	—	—
18	C	0.188	A1	NVGA	0.945	—	C	52.0	29.5		0.85	4.2	11000	7450
18A	C	0.188	A1	NVBA	0.945	—	C	52.0	29.5	Now designated as RG-219/U	0.85	4.2	11000	7450

RG/U Type	Innar Conductor		Dielectric Material	Jacket		Shield		Impedance (Ohms)	Cap. (pf/ft)	Engineering Data	Attenuation in db/100 ft		Max. Opr. Volts RMS	Max. Power Watts @ 50mc
	Mat.	Strand		Mat.	O.D.	Inner	Outer				(100 mc)	(1000 mc)		
19	C	0.250	A1	NVG	1.120	—	C	52.0	29.5		0.68	3.5	14000	8400
19A	C	0.250	A1	NVB	1.120	—	C	52.0	29.5	Now designated as RG-220/U	0.68	3.5	14000	8400
20	C	0.250	A1	NVGA	1.195	—	C	52.0	29.5		0.68	3.5	14000	8400
20A	C	0.250	A1	NVBA	1.195	—	C	52.0	29.5	Now designated as RG-221/U	0.68	3.5	14000	8400
21	HR	0.0508	A1	NVG	0.332	SC	SC	53.0	29.0		15.0	46.0	2700	—
21A	HR	0.0508	A1	NVB	0.332	SC	SC	53.0	29.0	Now designated as RG-222/U	15.0	46.0	2700	—
22	C	7/0.0152	A1	V	0.405	—	TC	95.0	16.0	Two conductors	3.6	13.7	1000	—
22A	C	7/0.0152	A1	NVG	0.420	—	TC	95.0	16.0	Two conductors	—	—	1000	—
22B	C	7/0.0152	A1	NVB	0.420	TC	TC	95.0	16.0	Two conductor balanced cable. Conductors twisted	—	—	1000	—
23	C	7/0.0285	A1	V	0.650	C	C	125.0	12.0	Two conductors	1.7	7.3	3000	600
23A	C	7/0.0285	A1	NVB	0.650	C	C	125.0	12.0	Two conductors	1.7	7.3	3000	600
24	C	7/0.0285	A1	VA	1.034	C	C	125.0	12.0	Two conductors	1.7	7.3	3000	600
24A	C	7/0.0285	A1	NVBA	1.034	C	C	125.0	12.0	Two conductors RG-23A/U with armor	1.7	7.3	3000	600
29	C	20 AWG	A1	P	0.184	—	TC	53.5	28.5	Replaced by RG-58/U	4.8	18.0	1900	300
33	C	10 AWG	A1	Lead	0.470	—	—	51.0	30.0		—	—	6000	—
34	C	7/0.0285	A1	V	0.625	—	C	71.0	21.5		1.8	7.5	5200	—
34B	C	7/0.0249	A1	NVB	0.630	—	C	75.0	21.5		1.4	5.9	5200	—
35	C	9 AWG	A1	NVGA	0.945	—	C	71.0	21.5		0.7	4.2	10000	7450
35B	C	0.1045	A1	NVBA	0.945	—	C	75.0	21.5		0.85	3.6	10000	7450
36	C	0.162	A1	V	1.180	—	C	69.0	22.0		—	—	13000	—
42	HR	21 AWG	A1	NVG	0.342	SC	SC	78.0	20.0	Replaced by RG-21/U	17.0	54.0	2700	—
54	C	7/26 AWG	A1	V	0.275	—	C	58.0	27.0	Replaced by RG-54A/U	—	—	2500	—
54A	C	7/0.0152	A1	P	0.250	—	TC	58.0	26.5		3.1	12.0	3000	—
55	C	20 AWG	A1	P	0.206	TC	TC	53.5	28.5		4.2	16.0	1900	335
55A	SC	0.035	A1	NVB	0.216	SC	SC	50.0	29.0		4.8	16.8	1900	335
55B	SC	0.0320	A1	PB	0.206	TC	TC	53.5	28.5	Now designated as RG-223/U	4.8	16.8	1900	335
57	C	7/0.0285	A1	V	0.625	—	TC	95.0	17.0	Two conductors	3.0	13.6	3000	—
57A	C	7/0.0285	A1	NVB	0.625	—	TC	95.0	17.0	Two conductors	3.0	13.6	3000	—
58	C	20 AWG	A1	V	0.195	—	TC	53.5	28.5		4.2	16.0	1900	300
58A	TC	19/0.0071	A1	V	0.195	—	TC	52.0	28.5		5.3	22.0	1900	300
58B	C	20 AWG	A1	NVB	0.195	—	TC	53.5	28.5		4.2	16.0	1900	300

RG/U Type	Inner Conductor		Dielectric Material	Jacket		Shield		Imped-ance (Ohms)	Cap. (pf/ft)	Engineering Data	Attenuation In db/100 ft		Max. Opr. Volts RMS	Max. Power Watts @ 50mc
	Mat.	Strand		Mat.	O.D.	Inner	Outer				(100 mc)	(1000 mc)		
58C	TC	19/0.0071	A1	NVB	0.195	—	TC	50.0	28.5		5.3	22.0	1900	300
59	CW	22 AWG	A1	V	0.242	—	C	73.0	21.0		3.8	14.0	2300	—
59A	CW	0.0230	A1	NVB	0.242	—	C	75.0	21.5		4.0	14.0	2300	—
59B	CW	0.0230	A1	NVB	0.242	—	C	75.0	21.0		4.0	14.0	2300	—
62	CW	22 AWG	A2	V	0.242	—	C	93.0	13.5		3.1	10.0	750	—
62A	CW	0.0253	A2	NVB	0.242	—	C	93.0	13.5		3.1	10.0	750	—
62B	CW	7/32 AWG	A2	NVB	0.242	—	C	93.5	14.5		3.1	10.0	750	—
63	CW	22 AWG	A2	V	0.405	—	C	125.0	10.0		2.0	7.0	1000	—
63A	C	22 AWG	A1	V	0.405	—	C	125.0	10.0	Replaced by RG-63B/U	2.0	7.0	1000	—
63B	CW	0.0253	A2	NVB	0.405	—	C	125.0	10.0		1.99	6.4	1000	—
65	F	32 AWG	A1	V	0.405	—	C	950.0	44.0	High impedance video cable used as delay line	—	—	1000	—
65A	F	32 AWG	A1	NVB	0.405	—	C	950.0	44.0		—	—	1000	—
71	CW	22 AWG	A2	P	0.250	TC	TC	93.0	13.5		3.1	10.0	750	—
71A	CW	22 AWG	A2	V	0.250	TC	TC	93.0	13.5		3.1	10.0	750	—
71B	CW	0.0253	A2	PB	0.250	TC	TC	93.0	14.5		3.1	10.0	750	—
72	CW	22 AWG	A2	V	0.630	—	C	150.0	—		—	—	—	—
73	C	20 AWG	A1	C	0.275	C	C	25.0	—		—	—	—	—
74	C	10 AWG	A1	NVGA	0.615	C	C	52.0	29.5		1.4	6.2	5500	1280
74A	C	0.102	A1	NVBA	0.615	C	C	52.0	29.5	Now designated as RG-224/U	1.4	6.2	7000	1280
79	CW	22 AWG	A2	VA	0.475	—	C	125.0	10.0		2.0	7.0	1000	—
79B	CW	0.0253	A2	NVBA	0.475	—	C	125.0	11.0	RG-63B/U with armor	2.0	7.0	1000	—
83	C	10 AWG	A1	V	0.405	—	C	35.0	44.0		2.8	9.6	2000	—
84A	C	0.1045	A1	NVBL	1.000	—	C	75.0	21.5	RG-35B/U with lead sheath in lieu ol armor	—	—	10000	—
85A	C	0.1045	A1	NVBA	1.565	—	C	75.0	21.5	RG-84A/U with special armor	—	—	10000	—
87A	SC	7/0.032	F1	FG	0.425	SC	SC	50.0	29.5	For replacement purposes only. Use RG-225/U	—	—	5000	—
89	CW	22 AWG	A2	V	0.632	—	C	125.0	10.0		2.0	7.0	1000	—
93	C	19/0.040	F2	FG	0.710	—	C	50.0	29.0	Replaced by RG-117/U	—	—	10000	—
94	SC	19/0.0255	F2	FG	0.445	C	C	50.0	29.0	Now designated as RG-226/U	—	—	7000	—
94A	SC	19/0.0254	F2	FG	0.500	C	C	50.0	27.0		—	—	7000	—
100	C	19/0.0147	A1	V	0.242	—	C	35.0	44.0		—	—	2000	—
108	TC	7/28 AWG	A1	NVG	0.235	—	TC	78.0	24.5	Two conductors	—	—	1000	—

RG/U Type	Inner Conductor		Dielectric Material	Jacket		Shield		Imped-ance (Ohms)	Cap. (pf/ft)	Engineering Data	Attenuation in db/100 ft		Max. Opr. Volts RMS	Max. Power Watts @ 50mc
	Mat.	Strand		Mat.	O.D.	Inner	Outer				(100 mc)	(1000 mc)		
108A	TC	7/28 AWG	A1	NVB	0.235	—	TC	78.0	24.5	Two conductors	—	—	1000	—
111	C	7/0.0152	A1	NVGA	0.490	TC	TC	95.0	16.0	Two conductors	—	—	1000	—
111A	C	7/0.0152	A1	NVBA	0.490	TC	TC	95.0	16.0	Two conductors	—	—	1000	—
114	CW	0.007	A2	V	0.405	—	C	185.0	6.8	Special low capacitance	—	—	1000	—
114A	CW	0.007	A2	NVB	0.405	—	C	185.0	6.8	Special low capacitance	—	—	1000	—
115	SC	7/0.028	F2	FG	0.375	SC	SC	50.0	29.5		—	—	5000	—
115A	SC	7/28 AWG	F2	FG	0.415	SC	SC	50.0	29.5		—	—	4000	—
116	SC	7/0.032	F1	FGA	0.490	SC	SC	50.0	29.5	Now designated as RG-227/U	—	—	5000	—
117	C	0.188	F1	FG	0.730	—	C	50.0	29.0	Now designated as RG-211/U	—	—	7000	—
118	C	0.188	F1	FGA	0.795	—	C	50.0	29.0	Now designated as RG-228/U	—	—	7000	—
119	C	0.102	F1	FG	0.465	C	C	50.0	29.0	High temperature	—	—	6000	—
120	C	0.102	F1	FGA	0.525	C	C	50.0	29.0	RG-119/U with armor	—	—	6000	—
122	TC	27/36 AWG	A1	NVB	0.160	—	C	50.0	29.5	Same as RG-58A/U except smaller size and lighter weight	7.0	29.0	1900	—
124	TCW	22 AWG	F2	FG	0.240	—	TC	73.0	20.5	Replaced by RG-140/U	—	—	2300	—
125	CW	26 AWG	A2	NVB	0.600	—	C	150.0	7.8	Special low capacitance	—	—	2000	—
126	HR	7/0.0203	F1	FG	0.280	—	HR	50.0	29.0	High attenuation	—	70.0	3000	—
130	C	7/0.0285	A1	V	0.625	—	TC	95.0	17.0	Two conductors	—	—	8000	—
131	C	7/0.0285	A1	VA	0.710	—	TC	95.0	17.0	RG-130/U with armor	—	—	8000	—
133	C	21 AWG	A1	V	0.405	—	C	95.0	16.2		—	—	4000	—
140	SCW	0.025	F1	FG	0.233	—	SC	75.0	21.0	High temperature similar to RG-59A/U	—	—	2300	—
141	SCW	0.0359	F1	FG	0.190	—	SC	50.0	28.5		—	—	1900	—
141A	SCW	0.0359	F1	FG	0.190	—	SC	50.0	28.5	High temperature similar to RG-58C/U	—	—	1900	—
142	SCW	0.0359	F1	FG	0.206	SC	SC	50.0	28.5		—	—	1900	—
142A	SCW	0.0359	F1	FG	0.206	SC	SC	50.0	28.5	High temperature similar to RG-55A/U	—	—	1900	—
143	SCW	0.057	F1	FG	0.325	SC	SC	50.0	28.5		—	—	3000	—
143A	SCW	0.059	F1	FG	0.325	SC	SC	50.0	28.5	High temperature similar to RG-5B/U	—	—	3000	—
144	SCW	7/0.0179	F1	FG	0.410	—	SC	75.0	20.5	High temperature similar to RG-11/U	—	—	5000	—
146	CW	0.007	F3	FG	0.375	—	C	190.0	6.0	High temperature, low capacitance	—	—	1000	—
147	C	0.250	A1	VA	1.937	—	C	52.0	29.5	RG-19/U with armor	0.68	3.5	14000	8400

RG/U Type	Inner Conductor		Dielectric Material	Jacket		Shield		Imped-ance (Ohms)	Cap. (pf/ft)	Engineering Data	Attenuation in db/100 ft		Max. Opr. Volts RMS	Max. Power Watts @ 50mc
	Mat.	Strand		Mat.	O.D.	Inner	Outer				(100 mc)	(1000 mc)		
148	C	7/21 AWG	A1	VA	0.800	—	C	52.0	29.5	RG-8/U with armor	2.1	9.0	4000	1445
150	TC	7/26 AWG	A1	VA	—	—	C	75.0	—	RG-149/U with armor	—	—	—	—
149	TC	7/26 AWG	A1	V	0.405	—	C	75.0	—	Low noise	—	—	—	—
156	TC	7/21 AWG	A1	NVB	0.540	Three braids TC, GS, TC		50.0	30.0		—	—	10000	—
157	TC	19/24 AWG	A1	NVB	0.725	Same as RG-156/U		50.0	38.0		—	—	15000	—
158	TC	37/.0284	A1	NVB	0.725	Same as RG-156/U		25.0	78.0		—	—	15000	—
159	SC	20 AWG	F2	FG	0.195	—	SC	50.0	29.0	Replaced by RG-142/U	—	—	—	—
161	SB	7/38 AWG	F1	N	0.090	—	SC	70.0	20.0	Miniature	—	—	1000	—
164	C	0.1045	A1	NVB	0.870	—	C	75.0	—		0.85	3.6	10000	7450
165	SC	7/0.032	F1	FG	0.410	—	SC	50.0	—		—	—	5000	—
166	SC	7/0.032	F1	FGA	0.460	—	SC	50.0	—		—	—	5000	—
174	CW	7/34 AWG	A1	V	0.100	—	TC	50.0	30.4		9.0	30.0	1500	125
177	C	0.195	A1	NVB	0.895	SC	SC	50.0	—		—	—	11000	—
178	SCW	7/.0039	F1	K	0.079	—	SC	50.0	27.9		—	—	1000	—
178A	SCW	7/.004	F1	K	0.075	—	SC	50.0	27.9		—	—	1200	—
179A	SCW	7/.004	F1	K	0.105	—	SC	75.0	—		—	—	1200	—
180	SCW	7/.0039	F1	K	0.141	—	SC	93.0	15.3		—	—	1500	—
180A	SCW	7/.004	F1	K	0.145	—	SC	95.0	14.5		—	—	1500	—
181	C	7/26 AWG	A1	NVB	0.640	—	C	125.0	12.0	Two conductor	—	—	3500	—
187	SCW	7/0.004	F1	T	0.110	—	SC	75.0	—	High temperature miniature cable	—	—	1200	—
188	SCW	7/0.0067	F1	T	0.110	—	SC	50.0	—	High temperature miniature cable	—	—	1200	—
189	C	0.251	A2	P	0.875	—	SC	50.0	23.0		—	—	3500	—
190	TC	19/25 AWG	D	SR	0.700	GS	TC	50.0	50.0	Low noise pulse cable	—	—	3500	—
195	SCW	7/.004	F1	T	0.155	—	SC	95.0	—	High temperature miniature cable	—	—	1500	—
196	SCW	7/.004	F1	T	0.080	—	SC	50.0	—	High temperature miniature cable	—	—	1000	—
209	SCW	19/0.037	F3	PF	0.750	SC	SC	50.0	—		—	—	3200	—
210	SCW	0.0253	F2	FG	0.242	—	SC	93.0	14.5	Replaces RG-62C/U	3.1	10.0	750	—
211	C	0.190	F1	FG	0.730	—	C	50.0	29.0	Formerly RG-117/U	—	—	7000	—
212	SC	0.0556	A1	NVB	0.332	SC	SC	50.0	29.5	Formerly RG-5B/U	2.4	9.1	3000	600
213	C	7/0.0296	A1	NVB	0.405	—	C	50.0	29.5	Formerly RG-8A/U	2.1	9.0	5000	1445
214	SC	7/0.0296	A1	NVB	0.425	SC	SC	50.0	29.5	Formerly RG-9B/U	2.3	8.6	5000	1445
215	C	7/0.0296	A1	NVBA	0.475	—	C	50.0	29.5	Formerly RG-10A/U	2.1	9.0	5000	1445

RG/U Type	Inner Conductor		Dielectric Material	Jacket		Shield		Impedance (Ohms)	Cap. (pf/ft)	Engineering Data	Attenuation in db/100 ft		Max. Opr. Volts RMS	Max. Power Watts @ 50mc
	Mat.	Strand		Mat.	O.D.	Inner	Outer				(100 mc)	(1000 mc)		
216	TC	7/0.0159	A1	NVB	0.425	C	C	75.0	20.5	Formerly RG-13A/U	2.15	8.4	5000	1445
217	C	0.106	A1	NVB	0.545	C	C	50.0	29.5	Formerly RG-14A/U	1.4	5.6	7000	1280
218	C	0.195	A1	NVB	0.870	—	C	50.0	29.5	Formerly RG-17A/U	0.96	4.4	11000	7450
219	C	0.195	A1	NVBA	0.945	—	C	50.0	29.5	Formerly RG-18A/U	0.96	4.4	11000	7450
220	C-	0.260	A1	NVB	1.120	—	C	50.0	29.5	Formerly RG-19A/U	0.69	3.6	14000	8400
221	C	0.260	A1	NVBA	1.195	—	C	50.0	29.5	Formerly RG-20A/U	0.69	3.6	14000	8400
222	HR	0.0556	A1	NVB	0.332	SC	SC	50.0	—	Formerly RG-21A/U	15.0	46.0	2700	—
223	SC	0.035	A1	NVB	0.216	SC	SC	50.0	29.5	Formerly RG-55A/U	4.6	16.8	1900	335
224	C	0.106	A1	NVBA	0.615	C	C	50.0	29.5	Formerly RG-74A/U	1.4	5.6	7000	1280
225	SC	7/0.0312	F1	FG	0.430	SC	SC	50.0	29.5	Formerly RG-87A/U	—	—	5000	—
226	SC	19/.0254	F2	FG	0.500	C	C	50.0	27.0	Formerly RG-94A/U	—	—	7000	—
227	SC	7/0.0312	F1	FGA	0.490	SC	SC	50.0	29.5	Formerly RG-116/U	—	—	5000	—
228	C	0.190	F1	FGA	0.795	—	C	50.0	29.0	Formerly RG-118/U	—	—	7000	—
235	SC	7/0.028	F2	PF	0.750	SC	SC	50.0	29.5	RG-115A/U with PF jacket	—	—	5000	—
236	C	0.160	A1	See Shield	0.5	Alum. Tube	—	50.0	24.0		0.8	5.4	1000	—
237	C	0.160	A1	P	0.6	Alum. Tube	—	50.0	24.0		0.8	5.4	1000	—
244	C	0.102	A1	See Shield	0.5	Alum. Tube	—	75.0	15.5		0.74	4.8	1200	—
245	C	0.102	A1	P	0.6	Alum. Tube	—	75.0	15.5		0.74	4.8	1200	—
246	C	0.189	A1	See Shield	0.88	Alum. Tube	—	75.0	15.6		0.42	3.0	2200	—
247	C	0.189	A1	P	1.02	Alum. Tube	—	75.0	15.0		0.42	3.0	2200	—

Dielectric Materials
A1 Solid polyethylene
A2 Air-spaced polyethylene
F1 Solid tetrafluorethylene (Teflon)
F2 Taped tetrafluorethylene (Teflon)
F3 Air-spaced tetrafluorethylene (Teflon)
D Layer of synthetic rubber dielectric between thin layers ducting rubber

Conductor and Shield
C Copper
CW Copper-covered steel (Copperweld)
F Formex F
HR High resistance wire
GS Galvanized steel
SB Silver-covered cadmium bronze
SC Silver-covered copper
SCW Silver-covered copper-covered steel
TC Tinned copper
TCW Tinned copper-covered steel

Jacket Materials
V Low temperature black polyvinylchloride, contaminating type plasticizers
NVB Low temperature black polyvinylchloride, non-contaminating type plasticizers
NVBA Same as NVB, but with armor
NVG Grey polyvinylchloride, non-contaminating type plasticizers
NVGA Same as NVG, but with armor
P Stabilized natural polyethylene
PB High molecular weight black polyethylene
PF Polyester fiber impregnated with high temperature lacquer over wrapped or extruded silicone rubber over silicone impregnated fiberglass
FG High temperature lacquer impregnated fiberglass braid, usually with Teflon tape between shield and jacket
FGA Same as FG, but with armor
SR Black synthetic rubber
T Tetrafluorethylene (Teflon)
K Kel-F
N Nylon
C Copper braid
Lead Lead sheath

ıble 11. Foamed dielectric coaxial cables.

Part No.	RG/U Type	Inner Conductor Mat.	Inner Conductor Strand	Dielectric Material	Jacket Mat.	Jacket O.D.	Shield Inner	Shield Outer	Impedance (Ohms)	Cap. (pf/ft)	Attenuation in db/100 ft (100 mc)	Attenuation in db/100 ft (1000 mc)
					BELDEN FOAM-CORE							
8211	59	CW	22 AWG	FP	PB	0.242	C	—	80	16.3	3.4	10.7
8212	59	CW	20 AWG	FP	PB	0.242	C	—	75	17.3	3.2	13.8
8213	11	C	14 AWG	FP	PB	0.405	C	—	75	17.3	1.5	5.8
8214	8	C	7 x 19	FP	V	0.403	C	—	50	26.0	1.8	6.3
8219	58	C	19 x 32	FP	V	0.195	C	—	50	26.0	4.8	16.1
					AMPHENOL POLYFOAM							
521-100	11	C	14 AWG	FP	PB	0.405	C	—	75	16.5	1.4	6.6
521-111	8	C	7 x 19	FP	V	0.405	C	—	50	24.5	1.8	7.2
521-685	62A	CW	0.023	FP	NVB	0.242	C	—	93	14.5	—	—
621-700	59A	CW	22 AWG	FP	V	0.195	C	—	72	17.0	3.4	13.1
621-701	59	CW	22 AWG	FP	V	0.195	C	—	72	17.0	3.4	13.1
621-715	59	CW	22 AWG	FP	PB	0.195	C	—	72	17.0	3.4	13.1

Next month in 73:
Another special book feature—

The Coaxial Connector Handbook

by Jim Fisk WA6BSO

And in the September issue—

Coaxial Accessories

by Jim Fisk WA6BSO

(Continued from page 4)

size, weight, reliability, ruggedness, power drain, ease of circuit construction, and in many cases, simplicity, performance and cost. Yet the 1966 ARRL Handbook gives semiconductors, except for silicon diodes, very short shrift. There is a short chapter on semiconductors in general. Then the receiving chapter mentions and illustrates a transistor mixer for below 20 MHz with a very old transistor, a simple *if* system with older transistors and two rf amplifiers. This 58 page chapter on receiving also contains two transistor construction projects, a four transistor regenerative receiver-code practice oscillator, and a transistorized Selectoject.

The 81 page transmitter section devotes a little over half a page to transistor output circuits. It also describes a simple rf powered keying monitor (a similar device is described in the chapter on monitoring).

The power supply chapter has a number of schematics using silicon diodes, but doesn't even mention zener diodes. There is a long section on VR tubes, even though zeners are far more versatile, smaller, and usually cheaper.

The VHF receiver uses two transistors in the audio section of a 420 MHz unstabilized transceiver.

The VHF transmitting chapter uses IN34 diodes as rf voltmeters for tuning the transmitters.

The mobile equipment chapter is at the same time, most conscious of transistors, and yet most surprising since it uses transistors in at least some of the modulator and power supply circuits, but uses tubes in all the converters, though one does have a transistor mixer and oscillator.

The test equipment chapter includes an excellent pulsed two tone oscillator for SSB and other checks. There's also a field strength meter with a transistor meter amplifier.

The reference chapter on vacuum tubes and semiconductors gives no data on transistors except for the common basing diagrams. The reason is obvious: there are well over 5000 transistors now being manufactured and the ARRL apparently didn't desire to try to choose from among them for recommended devices.

In view of the above uses of transistors in the ARRL Handbook, I don't feel that the most prejudiced reader could state that the ARRL Handbook covers transistors very well. Hence my question.

So I was very happy to have the chance to hear Byron Goodman W1DX, editor of the

Handbook, speak on the role of semiconductors in amateur radio at the ARRL National Convention. His talk answered my question about their treatment of transistors.

W1DX apparently regards transistors as novelties. He seems to feel that people will get over their enthusiasm for transistors one of these days. He didn't mention whether he expects people to go back to tubes or whether he expects something better to come along. Of course, there are better things coming, such as FET's, with many of the advantages of both tubes and transistors, but he didn't mention them in his talk. I guess he just overlooked them.

Here are some of W1DX's points about transistors:

1. The CK722 (the first transistor commercially available to hams) wasn't so great.

2. No transistor front ends are as good as tube ones, as far as he knows. [This would undoubtedly come as a surprise to many engineers.]

3. Good transistors are expensive so hams use them only when they can steal them. [How many tubes can you buy new for 46¢ and even less? Aside from RF power uses, most transistors are cheaper than equivalent tubes.]

4. Transistors are prone to overloading ar intermodulation. [So are tubes if they're n handled properly. Transistor circuits can gi excellent results if designed properly. Als note that the darling of the ARRL these da is the 7360 tube, which they use as a mixer avoid the overload and cross modulation fro more conventional tubes. It costs abo $3.75, roughly the same as an FET that excellent for this use.]

5. Transistors are compact, but this isn too important since equipment can be mac too small for easy tuning–transistors are fin for CB equipment [what a red herring] sinc they're on fixed channels, but not necessar for tunable equipment.

6. Transistor VFO's tend to drift and aren stable. [Sure, if they're not designed properl But it's a lot easier to make low drift transi tor oscillators than tube ones.]

7. Transistor output circuits are weird an unfamiliar looking. [Enough said.]

8. Transistors don't work well in parallel a one tends to hog the current. [Tubes in para lel tend to oscillate, but that can be prevente easily. Likewise, equalizing resistors are use with transistors in parallel.]

9. Varactor triplers are all right for VHI [But there're no practical ones in the HB.]

10. Transistors are all right for *VHF* lo noise amplifiers. [None of those in the HI either.]

11. Silicon diodes are excellent if you' careful.

12. Transistors are easily adaptable t etched circuits, but etched circuits aren't to practical for individuals. Maybe some da enterprising small manufacturers will mak boards for projects in electronics magazine and sell them. [They have and do. Even QS has had projects like that.]

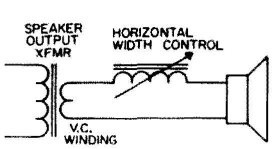
I got the impression that W1DX felt th hams have little reason to use transistors e cept in mobile equipment and that oth equipment using transistors uses them for th novelty value. Is that why Motorola, RC Scott, Raytheon, Davco and others are usin transistors? For novelty?

I don't think so. I feel that hams shoul make every attempt to keep up with mode practice if we are to justify our existence an not to be left behind, ignored and discredite Most amateurs learn their first amateur rad from ARRL books. Will these hams stay b hind the times? Or will they discover mode practices elsewhere? Or will the Handboo be brought up to date? For the sake of ha radio, I certainly hope so.

. . . Pa

Simple Noise Filter

This simple noise filter may be added to your present communications receiver with a minimum of parts (one part). It will provide you with many more hours of operating pleasure if such sounds as high pitched heterodynes and static crashes bother you. The speaker output impedance is 3.2 ohms on the HQ-145 to which this filter was added but should work equally well on receivers of other output impedances.



Almost any old TV horizontal width coil will work. The one I used had a sliding iron core slug and an inductance of approx. 2-17 mH. The screw type would work just as well but the sliding slug type is quicker to adjust.

. . . KØT6R

Caveat Emptor?

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FACTORYWIRED, PTT, sequence keyed Ranger I, some scratches. Good electrically. Now have transceiver. Bargain at $100. Dean Straw, KH6DKD/1. D4, 386 Prospect Street, New Haven, Conn. 77101

WANTED: Copy of 8 Oct 1956 issue of LIFE magazine Make offer. W5NKG, R. Lent, 5634 Seacomber, San Antonio, Texas 78242.

JACKSONVILLE, ILL. ARC annual hamfest, July 10, 1966. For information. WN9OXH, Secretary. 1010 Dayton St. Jacksonville, Ill. 62650.

WABASH VALLEY ARA annual VHF picnic, Sunday July 31. At Turkey Run State Park, about 40 miles north of Terre Haute, one mile off U. S. Route 41 and on Indiana Route 47. Swap tables, eyeball QSO's, entertainment for the ladies. For more information contact K9EBK, Wabash Valley ARA, Box 81, Terre Haute, Indiana. 47808.

HQ170, $200. Heath Apache, $125. SB-10, $50. All in excellent condition. Will deliver 300 miles. W. L. Johnson, W5FPI/6, 205 Mar Vista Drive, Monterey, Calif.

RTTY mod 26 commercial transistorized TU & Osc. Aligned ready to go. My cost $125. HT 32 one owner, excellent $225. Stan Miln K6RMR, 2912 Overland Ave., Los Angeles, Calif. 90064.

CW FILTER, 500 cycles. No receiver alterations, plugs into phone jack. 6 DB gain. $26.50. Guaranteed. Northwest Electronic Repair, 11557 Evanston North, Seattle, Wash.

HALLICRAFTERS SX-117 Receiver. Perfect condition. Manual and original carton. $250. C. McDowell, W7UB, 2455 SW Montgomery, Portland, Oregon.

QSL's Free samples. Self-addressed stamped envelope. Hamprin. Box 235, Troy, Michigan 48084.

QSL CARDS???? Largest variety samples 25¢. Sakkers Printery, W8ded, Holland, Michigan.

6-12-115 Volt Gonset G66B receiver $49. G77A Transmitter $69. Super 6 Converter $9. 80-10 Coil-Whip-Mount $9. K6KUQ, 2812 10th, Arcadia, Calif.

SCR 16 amp prv 1.00, diodes 200/750 ma 10/1.00. RG 13AU coax .07 ft., mixed sfe fuses 25/1.00. glass p. c. board 13 x 7 1.00 tantalex capacitors 75/30v 4/1.00. 5 p.s.t. rotary switch 4/1.00. mixed crystals 10/1.75. Best deals on new ham gear wend and see. used gear wanted. Hirsch Sales So. 219 California Dr. Buffalo, N. Y. 14221.

GONSET SIDEWINDER 6 Meter Transceiver with AC and DC supplies. $350.00 or trade for ??? WA9WP, Vic Mattern, 1200 South Hough Street, Barrington, Ill. 60010.

QSL RUBBER STAMP 3" x 5". Free sample impressions and blank, complete stamp $5.00 P. P. D. Other ham stamps $1.00 up. Wes's Shop W1FP. RFD 1, Amesbury, Mass. 01913.

ALL MAKES of new and used amateur equipment. Write or call Bob Grimes, 89 Aspen Road, Swampscott, Mass. Tel: 617-598-9700 or 617-598-2530.

JULY BARGAINS: Drake 2A $150. TR3 AC supply $485. Globe King 400-D $195. HQ-170 $175. Heath HA-20 $89. Valiant $159. Lafayette HE45A & HE61A $95. NCX-3 $235. NCX-5 $550. Swan 240 $239. Many other bargains. Write for list and trades. Freck Radio & Supply Co. Tenny Freck W4WL, 38 Biltmore Ave., Asheville, North Carolina.

COMPONENTS BARGAINS: Transformers, tubes, meters, capacitors, receiving and transmitting, resistors, fixed, variable, coaxial fittings, switches, tube sockets. Free list. Ken Maas W9AZA, Burlington, Wisconsin, 53105.

CLEANING HOUSE: Keyer $10. B. C. smc VFO with power supply $15. 6mtr. Ameco converter with power supply $40. 20W novice xmtr 80,40 $15. RME 6900 & speaker, like new $225. Lettine 242 (need Mod xfmr.) $15. AR2 rotator & box $15. First check takes any or all. You pay shipping. Harvey Lawrence, WB2GVF RD 2, Bath, N. Y. 14810.

PERFECT HQ-170AC like new $250. Knight T-60 $30. Clyde Freed K7WMM 2317 Lindley Way, Klamath Falls, Oregon 97601.

MOTOROLA new miniature seven tube 455 kc *if* amplifier discriminator with circuit diagram. Complete at $2.50 each plus postage 50¢ each unit. R and R Electronics, 1953 South Yellowsprings, Springfield, Ohio.

CONVERTERS. World's largest selection of frequencies. Ham TV vidicon cameras and parts at low factory-direct prices. See them all now in our full page ad in this issue. Vanguard Labs, 196-23 Jamaica Ave., Hoilis, N.Y. 11423.

WE WILL PAY CASH: Wanted, popular, late model unmodified amateur equipment. Highest prices paid for clean, good operating gear. Write Graham Radio, Dept. 10, Reading, Massachusetts.

ARE YOU SINCERE? Are you really looking for the best deal on a new or fully guaranteed used unit? Let us convince you with a specific quote that will **really** save you money. Graham Radio, Dept. 10, Reading, Massachusetts.

W6SD 10th ANNUAL HAMFEST PICNIC—Sunday July 24—Door prizes, contests, fabulous program for family—Dollar donation—Write W6SD Hamfest, 2814 Empire, Burbank, Calif. 91504.

THIRD ANNUAL INTERNATIONAL HAM FEST will be held at the International Peace Gardens on the border between North Dakota and Manitoba on Saturday afternoon, July 16 and Sunday, July 17. For further information contact Robert Withey, WAØHUD, Willow City, North Dakota.

WOULD YOU BELIEVE, a Heath DX100B $135.00, National NC-173 $80.00, RME DB-23 Preselector $20.00, First offer over $200.00 gets everything, including a JT30 mike, antenna relay, and crystal calibrator. K3CHJ, Jim Toth, 2201 West Chester Pike, Broomall, ,Penna., 19008, (near Philadelphia)

ELMAC A54H (converted 12 volts), Morrow Converter 5BR, 12 volt Westinghouse dynamotor. $60.00. K2OZM, 9900 Pine Ave. Niagara Falls, New York.

LATEST SBE33 with DC Supply and Mounting plat $225.00. WA2FSD Martin Siegel, 11 Burbury Lane, Grea Neck, New York. Tel: 516 482-2737.

GALAXY V, like new. AC power supply with speake console. DC power supply and complete mobile installa tion including Hustler antenna for 80, 40 and 20. $525 Gerald Boles, 5305 North Drexel Street, Oklahoma City Oklahoma. WI 2-3159.

FREE ZENER DIODE and listing of our capacitors resistors, semiconductors, transformers, and F.M. equip ment. Send self-addressed stamped envelope to: Sura bachi Electronics, 214 E. Brett, Inglewood, Calif. 90302

WANTED: Hallicrafters S-36 VHF receiver; RMI DB22A preselector. Write, stating condition and price K3PRE, Edward R. Kowalski, 757 South Third Street Philadelphia, Penna. 19147.

EICO SSB TRANSCEIVER, 752 DC Power Supply, not assembled, 751 AC Power Supply, never on air. $300.00 Milo Heckt, WØTKU, 926 Joy Ave., Rapid City, S. Dak 57701.

WANTED: MILITARY, COMMERCIAL, SURPLUS. Airborne, Ground, Transmitters, Receivers, Testers, Accessories. Especially COLLINS. We pay freight and Cash. RITCO POB 156, Annandale, Virginia (703) 560-5480 COLLECT!

HT-41 $180, NC 183-D $120, Viking Valient $130, BC221 Frequency Meter w/AC Supply $75, Johnson TR Switch $15, Heath Q Multiplier $8, Pair 4- 250th w/Sockets $40 new, 5 URC 4 Transceivers converts to 2 meters $10 each. I will ship anywhere USA. W8CPZ, 901 East "F" Street, Iron Mountain, Mich. 49801.

TR 150 (80-6 mtrs.) $58, Ameco Converters for 6 and 2 $13 each. Converter power supply $9. Gonset G—76 plus DC supply (both almost new) $160 K2QHT 63 Robin Drive, Hauppauge, New York 516-AN-56479.

GALAXY V Complete with Speaker Console and A.C Power supply, Galaxy 2000 + Linear Amplifier (2 K.W PEP) with A.C. Power Supply, Value $949.00. This equipment has never been used, in original cartons Won at the Dayton Hamvention. Offers over $800.00 will be considered. WA8QEY, J. H. Meixner, 2401 Morningstar Ct., Kettering, Ohio, 45420.

SALE OR SWAP: JOYSTICK Antenna System, excellent condition. Make offer. Mitchel Katz, W2KPE 147-1 76th Avenue, Flushing, New York 11367.

APACHE AND MOHAWK Heathkit gear in very good condition. Factory checked. $325 or best offer. R. Milasich K9ECK, 405 Price, Calumet City, Illinois.

CLEGG THOR VI complete with both AC & DC Power Supply/Modulators, two cords, manual, original cartons Two years old, just returned from Clegg factory re aligned perfect. $350.00 FIRM: Shipped charges collec receipt first Money Order. George Haymans WA4NED Box 468, Gainesville, Georgia.

APARTMENT BOUND. Swap excellent 41 ft. E-Z way crankup tower, Hornet tri-bander, preferably for kilo watt Matchbox. Removal deal only. Blosser, W8DBK Chagrin Falls, Ohio.

DX-100 xmtr, perfect, w/op. manual. $1.00. Dage design TV camera, w/vidicon, RF, video jeep, tubes, schematics $125. Bert Gathercoal, W9QAP, 50 Westward Ho, North lake, Ill.

DRAKE T4X Txmr., R-4 Receiver, T4X Power Supply Thunderbolt Amplifier—Roy Anderson, Box 2116, Wil liamson, West Virginia 25661.

TECHNICAL MANUALS: ARC-27, CV-116/URR, $3.50 each, BC-1031, FGC-1, ARN-6, $3.00 each. Many others List 10¢. S. Consalvo, W3IHD, 4905 Roanne Drive Washington, D.C. 20021.

MUST SACRIFICE mint HT-37. Original owner, purchased new. First certified check for $275 takes it. Ship express collect. W8EWP, 7229 Saratoga, Reynoldsburg, Ohio 43068.

IOWA 75 METER Phone Net Picnic. Aug. 14, 1966. McHose Park, Boone, Iowa. Contact: Dr. J. H. Robinson, (515) 782-7719.

FEDERATION OF LONG ISLAND Radio Clubs Annual Picnic and Hamfest. July 17 at Hempstead Town Park, Point Lookout, L.I. Contact: W2NOS.

SPRINGFIELD Amateur Radio Club Annual Hamfest. 17 July, 1966 at Clark County Fairgrounds, 4 mi SE of Springfield, Ohio on Route 41.

SOUTHERN COUNTIES Amateur Radio Assoc of New Jersey will hold its annual outing 28 Aug. Egg Harbor Lake, Egg Harbor City, N.J. Contact: W2TUR.

ROGUE VALLEY Amateur Radio Clubs will host the Oregon Amateur Radio Assoc Annual Convention on Aug. 26-27. Speakers, Contests, Swap-shop, Entertainment. Contact: K7WXR, Medord, Ore.

BLUEBOOK prices save money. Take 10% off these prices without trade-ins. KWMI—$299.00; HW12—$119.00; NCX3—$219.00; Galaxy 300—$179.00; Communicator 3/6M—$149.00; NCL2000—$479.00; Thunderbolt—$349.00; 75A4—$479.00; SX99—$99.00; SX117—$259.00; HQ110—$134.00; DX100—$99.00; AF67—$59.00. Hundreds more. Free list. WRL, Leo, WØGFQ, Box 919, Council Bluffs, Iowa.

BUILD W1JJL's popular CPO-CWM (code practice oscillator-CW monitor) from the July 1965 73, page 32. The predrilled board with component locations silk-screened on it is only 50¢. The board with all parts mounted on the board is $3 and the unit assembled in an attractive case is a remarkable $7.95. Order today from the Harris Co., 56 E. Main St., Torrington, Conn.

160—2 METERS. HQ-170AC with Ameco 2m. Nuvistor Converter and 6m. preamp—$250. Johnson 250 watt Matchbox with R.F. power meter—$35. WA9NHQ, Bill Gode, 1036 Hillside, Northbrook, Ill.

LINEAR, ANTENNA, PATCH: Hallicrafters HT-31, 600 Watts cw ssb, excellent condition, new 811A'S, 3B28's, $110. New Hy-Gain 80-20 meter doublet, 248BDQ, parts package factory sealed, $22. Johnson phone patch, excellent, $12. Will ship at my expense, manuals included, upon receipt of check. Stan Flegler, K8RPA, 1400 Poxson, Lansing, Michigan, 48910.

NCL-2000, $400, late serial number. Hallicrafters FRR-274/SX73, $150. SBE-34, late, $300. 50′ Rohn #25 tower and Ham M rotor, $150. W7WRS, 1708 Valleyview, Las Vegas, Nevada.

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INDEX TO ADVERTISERS

Propagation Chart

JULY 1966

J. H. Nelson

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	14	7	7	7	7	7*	14	14	14	14
ARGENTINA	14	14	14	7	7	7	14	14	21	21	21	21
AUSTRALIA	14	14	14	14	7#	7	14	7#	7#	7#	14#	14
CANAL ZONE	21	14	14	14	7	7	14	14	14	14	21	21
ENGLAND	14	14	7	7	7	14	14	14	14	14	14	14
HAWAII	14	14	14	7#	7	7	7	7#	14#	14	14	14
INDIA	14	14	7#	7#	7#	7#	14	14	14	14	14	14
JAPAN	14	14	7	7#	7#	7#	14	14	14	14#	14	14
MEXICO	14	14	14	7	7	7	7	14	14	14	14	14
PHILIPPINES	14	14	7#	7#	7#	7#	14	14	14	14	14#	14
PUERTO RICO	14	14	7*	7	7	7	14	14	14	14	14	14
SOUTH AFRICA	7#	7#	7	7#	7#	14		14	14	14	14	14
U. S. S. R.	14	14	7	7	7	14	14	14	14	14	14	14
WEST COAST	14	14*	14	7*	7	7	7	14	14	14	14	14

CENTRAL UNITED STATES TO:

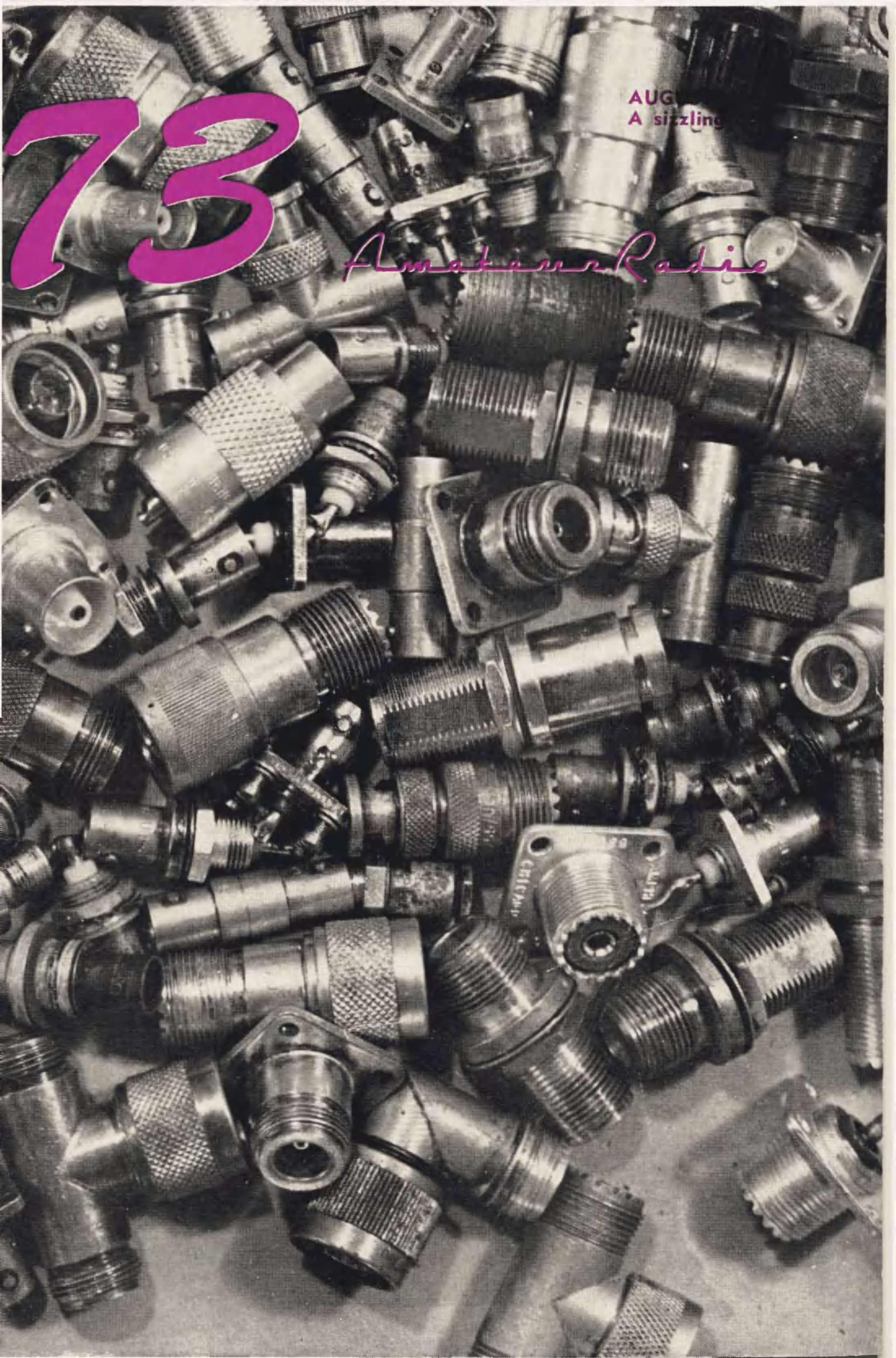
GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	14	7	7	7	7	7*	14	14	14	14
ARGENTINA	21	14	14	14	7	7	14	14	14	21	21	21
AUSTRALIA	14	14	14	14	14	7	7	7*	7#	7#	14#	14
CANAL ZONE	21	14	14	14	7*	7	14	14	14	14	21	21
ENGLAND	14	7*	7	7	7	7*	14	14	14	14	14	14
HAWAII	14	14	14	14	7	7	7	14*	14	14	14	14
INDIA	14	14	14	7#	7#	7#	7#	14	14	14	14	14
JAPAN	14	14	14	7	7	7	7	14	14	14#	14	14
MEXICO	14	14	14	7	7	7	7	7	14	14	14	14
PHILIPPINES	14	14	14	7#	7#	7#	7#	14	14	14	14#	14
PUERTO RICO	14	14	14	7*	7	7	14	14	14	14	14	14
SOUTH AFRICA	7#	7#	7	7#	7#	14	14	14	14	14	14	14
U. S. S. R.	14	14	7	7	7	7	14	14	14	14	14	14

WESTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	14	14	7	7	7	7	14	14	14	14
ARGENTINA	21	14	14	14	7	7	7#	14	14	21	21	21*
AUSTRALIA	21*	21	21	14	14	14	14	7	7	7#	14	21
CANAL ZONE	21	21	14	14	14	7	7	14	14	14	21	21
ENGLAND	14	7*	7	7	7	7	7	14	14	14	14	14
HAWAII	21	21*	21	14	14	14	14	7*	14	14	14	14
INDIA	14	14	14	14	7#	7#	7#	7#	14	14	14	14
JAPAN	14	14	14	14	14	7#	7	7	14	14#	14	14
MEXICO	14	14	14	7	7	7	7	7	14	14	14	14
PHILIPPINES	14	14	14	14	14	14	7#	7#	14	14	14#	14
PUERTO RICO	14	14	14	14	14	7	7	14	14	14	14	14
SOUTH AFRICA	7#	7#	7#	14	7#	7#	7#	14	14	14	14	14
U. S. S. R.	14	14	7	7*	7	7	7	14	14	14	14	14
EAST COAST	14	14*	14	7*	7	7	7	14	14	14	14	14

Very difficult circuit this hour.
* Next higher frequency may be useful this hour.

Good: 2-4, 7-10, 15-20, 27-31
Fair: 1, 5, 6, 11, 13, 14, 21, 22, 25, 26
Poor: 12, 23, 24
VHF DX: 1, 2, 3, 10, 11, 21, 22, 23, 24, 25


73
Amateur Radio
AUG
A sizzling

73 Magazine

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August 1966

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SPECIAL BOOK FEATURE

de W2NSD/1

never say die

. . . de W2NSD/5Z4

What started out originally to be a little visit to 5Z4ERR has grown into mammoth proportions and now consists of a three week hunting safari for four of us, a two week drive through darkest Africa, and a trip around the world via some very unusual spots. About the time you get this issue of 73 I'll be cringing in the bush of northern Kenya, peppering the landscape with bullets from my Weatherby. I think I can promise you that the animals will be pretty safe, though I just might bag a W5 or WA6, with a little luck.

The most difficult part of any trip is making the decision to go. There are so many reasons that such a thing is impossible that few get to the decision.

Once I had made the decision to go to Kenya I began to read about the country and got more and more enthused about hunting. I found that there are a lot of good reasons why people go over there and hunt. The main idea is to kill off the older male animals that are just past their prime and make room for the younger males. You don't just go over and shoot anything that moves like they do in New Hampshire during hunting season . . . you keep looking until you find an animal with outstanding antlers and try for him. If you are interested you will enjoy "Horn of the Hunter" by Ruark, the intimate story of his first hunting safari. It is a terrific story and available in paperback.

I'd heard about how horribly expensive safaris were, so I figured that this would never be for me. Then I read the Herter book on "The Truth About African Safaris, or How to Go On A Safari For $690." Seven bills I maybe could manage so I read the book and decided to have a try at it. I wrote to the outfit recommended by Herter and signed up for my first hunting trip. I've never shot anything more exotic than a hedgehog or a woodchuck, so they don't come much greener. I'll let you know how that works out, if you're interested.

My talking about the trip on twenty meters got me invitations to visit just about every country in Africa. At first I thought I might take along a couple other fellows and drive from Kenya down to South Africa. Then, when I got a closer look at the maps, I could see that this was a pretty big bite. After many more contacts with Africa and some thought the drive came down to a two week jaunt through Kenya, Uganda, Congo, Rwanda, Burundi and Tanzania. This will be plenty the first time around, I am sure.

The air fare around the world isn't that much more than the fare to Nairobi and back, so what the heck. I spun my world globe around a few times and traced out a path through some of the rarer countries, plus a trip through Australia and New Zealand. The interesting part was the long hard job of deciphering the air schedules from the book at the travel agency. Many places that I wanted to visit were out because there were either no scheduled flights or else maybe one a week . . . on a day when we couldn't make the trip without sitting around four or five days waiting for a plane. A trip that length with that many stops meant that each stop had to be for one or two days at best. Even so the trip strung itself out for almost eight weeks of flying!

Once the itinerary was decided there was the problem of getting all the air reservations, the hotel reservations and visas from all of the countries along the route. For instance, we got the whole trip just about set when I got

(Continued on page 70)

Editor's Ramblings

Imitation is the sincerest form of . . .

A note in K2MGA's editorial in the June CQ states that CQ is dropping its VHF, Novice, Club Forum, RTTY, YL and Space Communications columns. Reason given? "To make room for more current items of more general interest."

Speaking of CQ, the same editorial makes gleeful note of my statement in the May 73 that we do not have the staff here to answer technical questions from readers. The truth of the matter is that we try to answer questions, but must discourage them because of our small, overworked staff. As I mentioned last month, we'd like to find a number of qualified hams around the country who will answer questions for other hams in their spare time. We'll help them out with publicity and by printing articles answering the common questions they're asked.

Readers often ask us why we don't have a question and answer column. We've had a number of offers to write one (including one from a very prominent ham who wanted to write anonymously because he writes a monthly column for one of our competitors), but aren't convinced that it would be worthwhile. Most questions could be answered after a quick look through a radio handbook, catalog or magazine index. I'd rather see articles explaining common misunderstandings than the same "buy a *** for $*** from *** and install it in your ***" over and over.

Advertising in 73

You may have noticed that 73 is running more and more advertising, while our competitors aren't. Our new advertising manager, Jack Morgan, WØRA, has been working hard—and with excellent results. I hope that you are helping him out by getting off your duff and sending for the catalogs and equipment that you've been intending to buy. Think of the many things in 73 ads that you'd like, but just haven't gotten around to ordering. Shame on you.

But there are still a number of advertising holdouts, of course. The reasons are many. In a few cases, there are political considerations. Some important people in prominent companies disagree with Wayne about some things and feel that their principles are more important than the sales their companies are losing.

Another problem: advertising agencies. Virtually all manufacturers and most other advertisers have ad agencies which plan (we hope), design, make and place their ads. These agencies are paid by the magazines they insert ads in with a 15% discount on advertising space bills. This is a very odd arrangement and would seem to encourage ads in expensive magazines. Most agencies have little experience with specialized small magazines such as 73. They tend to place advertising on the basis of a simple plan: if it costs twice as much, it must be twice as good. Obviously, this is fallacious. Many factors affect advertising results: how loyal readers are, how thoroughly they read the magazine and ads, how much money they have to spend, how active they are, how the ads are arranged, and so on. 73 excels in all of these categories. Many testimonials and studies prove this.

Another reason manufacturers don't make best use of their advertising money is similar to the above. Mail order advertisers usually code their ads. They can tell which ads bring results. The mail order advertisers tell us over and over how well ads in 73 do. On the other hand, most large manufacturers depend on sales through radio dealers. They realize that most readers will visit their local dealers if they're interested in the products advertised. How can they tell which magazines give the best results? They can't—unless they

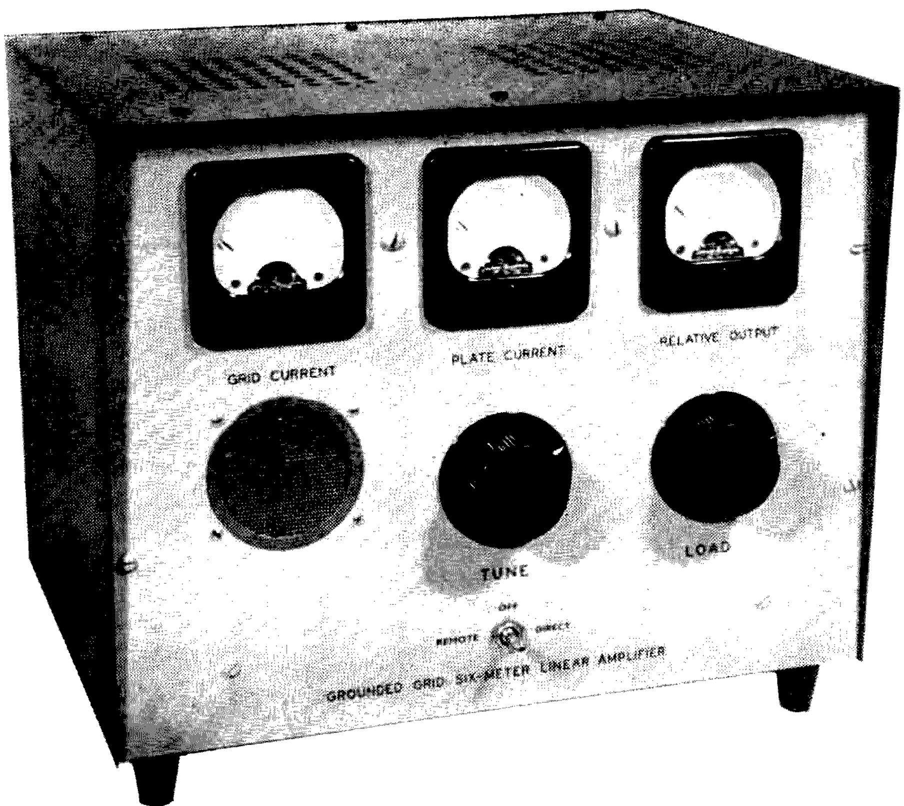
(Continued on page 92)

Price Comparison

These prices are for ads with no contract.

	73	CQ	QST
1 p	$268	$475	$537.60
1/2 p	138	255	256
1/4 p	71	125	128
1/8 p	37	70	64
1/16 p	20	36	32

There is no extra charge for second color (red) or bleed (running ads to edge of page) in full page ads in 73. QST charges $80 extra for the red and $53.76 for the bleed on a full page ad. CQ charges $50 extra for full page bleeds and you have to get a price on color from them.



R. L. Winklepleck WA9IGU
107 Berkeley Drive
Terre Haute, Indiana

More Power on Six

There are many amateurs who operate on six meters with AM rigs in the medium power class. By medium power we're talking about thirty to sixty watts into the final. This is excellent for local rag-chews and is nothing to be ashamed of when the skip is rolling in. However, there are times when it would be very satisfying to pour on the coal and blast through the QRM. Ever notice when the skip is hot the boys with the big signals can sit on one frequency and everybody comes to them?

Probably the quickest, easiest and cheapest answer is a linear amplifier. Don't listen to the static about the poor efficiency of AM linears. This is a point on which the experts aren't in full agreement. However, a few hours of operation with a good AM linear will convince you that, regardless of the theory, this is a happy solution.

Now comes the question as to the type of linear. The more common grounded cathode configuration is good but you'd have to swamp out most of your exciter power and that's downright wasteful. Grounded grid would use all those watts, running quite a few of them right through into the antenna. If we settle on a zero bias triode for our grounded grid linear things really get simple. No screen power supply, no grid bias supply and no neutralization worries. So, let's look around for our six-meter, AM, grounded grid, three to four hundred watt linear construction plans. This poor toiler in the vineyard couldn't find a thing to fill the bill. Here's one solution, evolved from only a small measure of blood, sweat and tears, which has provided many hours of operating pleasure.

Rather than make do with compromises so we could use a surplus tube or two, an Eimac

WA9IGU is the sales manager of the world's largest grower of greenhouse tomatoes and Bibb lettuce, the J. W. Davis Co. He has an MS in Agriculture from Purdue. He's written many articles on electronics, but most have been in the test equipment, photo and CB fields.

3-400Z[1] was chosen for the job. This is a high-mu triode designed for this type of service and with a plate dissipation of 400-watts. The tube, it's socket and chimney will set you back nearly fifty bucks—half the total cost of the linear—but it's well worth it. Practically everything was new except the fan, meters and antenna relay which came from surplus.

Components are assembled on a 3"x10"x14" chassis which could be much smaller if space is a problem. The layout is shown in the photos and this isn't too critical. Front and back panels are 11"x14" aluminum and the sides and top are made from a single sheet bent to U shape. One-half inch aluminum angle stock and sheet metal screws hold it together. Drill plenty of ventilation holes. Let's consider some of the features. A triple-pole, double-throw relay cuts the linear into and out of the antenna circuit for transceiver operation. It also virtually cuts off the tube between transmissions by inserting bias resistor R5 in the cathode circuit. The surplus relay used was powered by a voltage-doubler from the filament supply. A spdt center-off toggle switch in the relay circuit permits bypassing the linear even though it is powered, or operating it either directly, or indirectly from an extra set of relay contacts in the exciter. A tuned L input matches the 50-ohm output of the exciter to the 122-ohm input of the 3-400Z. Negative high voltage is isolated from chassis. It floats by the amount of the voltage drop across R6. Plate current is metered in the negative power lead to keep the extremely high voltage off the meter and because a meter in the plate lead would indicate both plate and grid current. The output circuit is a conventional pi-net and a relative power output meter is used for tune-up since plate current dips are uncertain at best. The filament and plate chokes are wound on ½" Teflon rod. Ceramic would be OK but don't use anything else—it might melt. L2 and L3 are each 31 turns of #12 Formvar bifilar wound and separated by a length of cord about the same diameter as the wire. If a Teflon rod is used the ends of the coils can be run through holes in the rod to hold them in place. L4 is 42 turns of #22 Formvar closewound on Teflon rod which is threaded at both ends to accept C8 and C9. L5 consists of four turns of 3/16" copper tube with a 1¼" inside diameter and ¼" spacing. A "D" cell makes a good winding form for L5 and the turns can then be spaced with a scrap of ¼" dowel. The parasitic choke is simply three 50-ohm, 2-watt resistors paralleled across a loop in the ½" copper strap making up the plate lead. This may appear useless but it's quite essential for stable operation.

There are a few precautions which might

1. The Amperex 8163 is almost identical

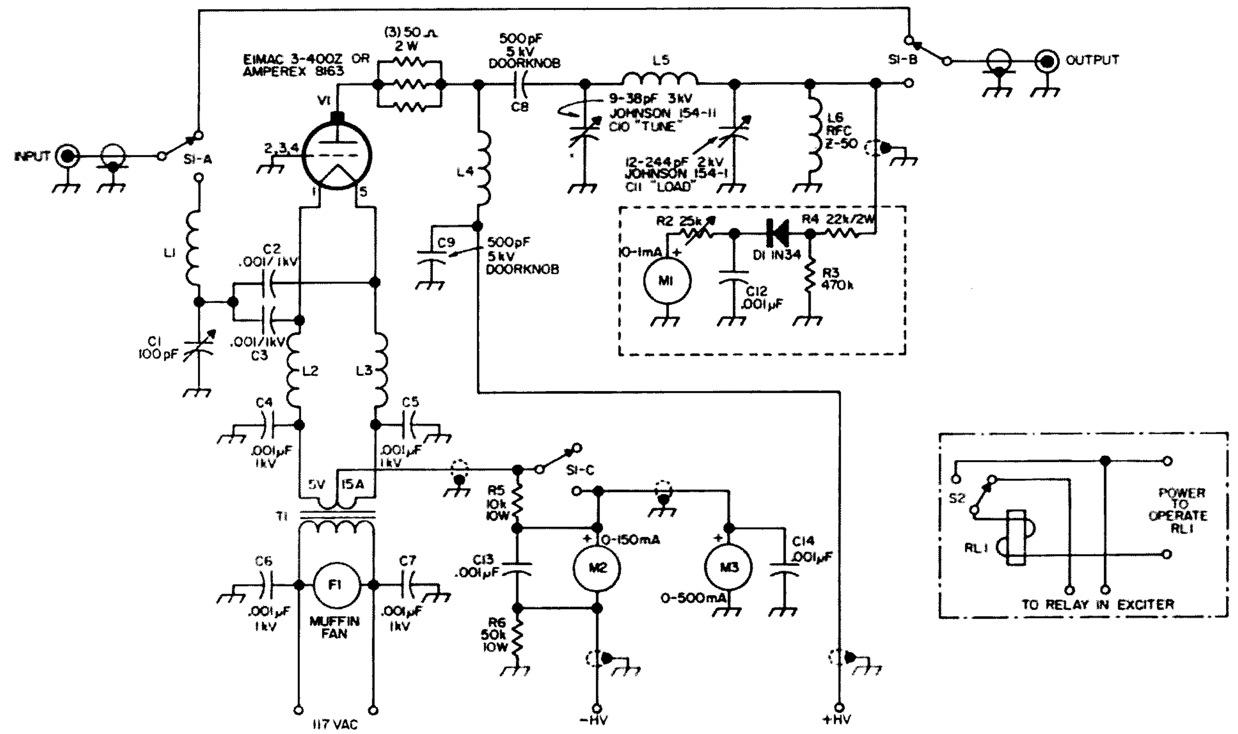
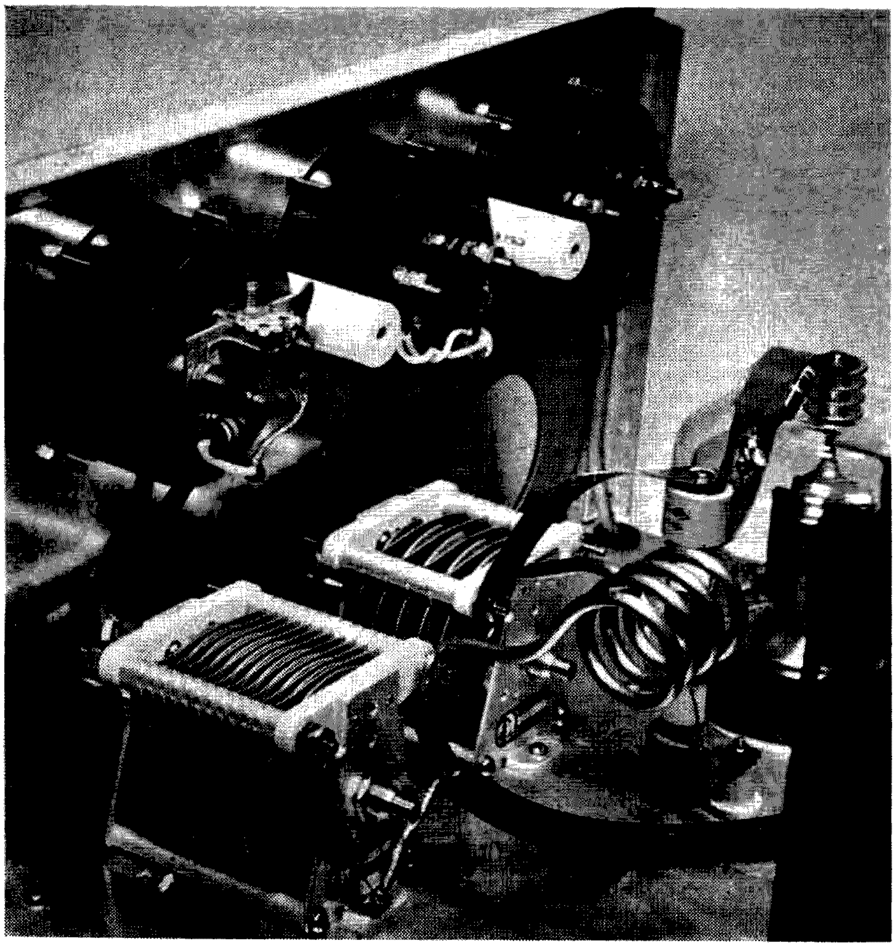


Fig. 1. Schematic of WA9IGU's grounded grid six meter linear amplifier. While WA9IGU uses it for AM, it could also be used for SSB. The coils are discussed in the text. The contacts labeled S1 are part of the transmit-receive relay RL1.

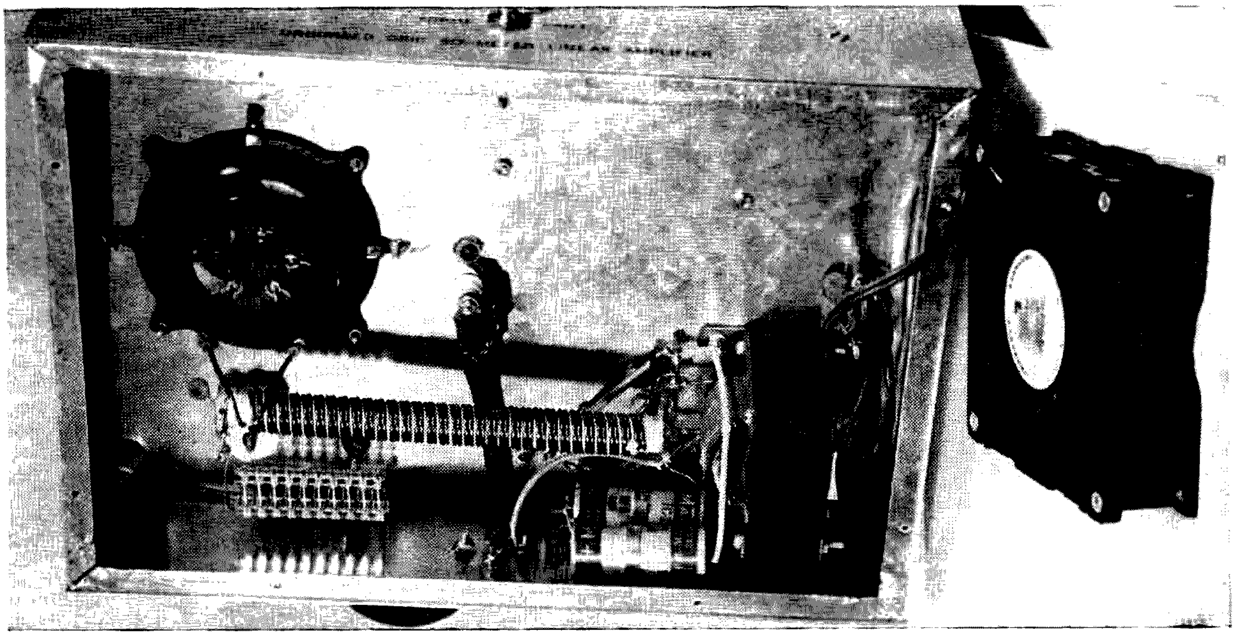
not be essential but probably will save trouble later. The three grid contacts on the socket are bonded directly through slots in the socket to chassis with the shortest possible copper straps. One-half inch copper strap is used from plate cap to the junction of L4/C8 and from the opposite side of C8 to C10. Shielded cable is used for all other power and rf leads. The heavy insulation of RG8-U is excellent for the positive high voltage lead. Try to keep the input circuit below chassis and the output above. The only exception is at the relay. The output metering circuit can be mounted on a scrap of punched circuit board which is fastened to the back of the meter by the meter terminals. One milliampere meters are used for grid and plate current by shunting them with short lengths of resistance wire to make them read the required values. Comparison with a reasonably accurate meter is used to establish the length of resistance wire to use. A U-shaped aluminum shield is installed behind the meters to prevent the radiation of rf energy through the meter holes and also to protect the meter movements from this energy. A view port in the front panel, shielded by aluminum or copper screen, is recommended. At high power the graphite anode starts to glow and it's a good idea to keep an eye on it. The bottom of the chassis is sealed with an aluminum plate in which the intake fan is mounted. Don't locate the fan directly under the tube. Mount the amplifier on one inch feet to insure adequate air movement. Observe these precautions and you should have a good, stable amplifier.

A word about the high voltage power supply, required to supply *only* the plate voltage. You'll probably want 2000 volts and you can go higher with this tube. It should be well filtered and, while you can drop it down with a light bulb in the primary of the transformer during initial testing, a variable voltage transformer is a real operating convenience. There are dozens of good power supply circuits and you may already have one which can be used. Remember that neither side of this high voltage supply is grounded. Shielded and grounded high voltage leads between power supply and linear keep both chassis' at the same potential.

Check and double-check all the wiring and please keep these precautions in mind during operation of this little bomb. Keep your hands out of the innerds except when the high voltage is definitely removed. You'll enjoy the



Layout of the components on top of the chassis. The rf output monitor circuit is located on the back of the nearest meter. The meters are normally covered by a shield.



Bottom view of the six meter linear. The Miniductor is L1. The filament chokes L2 and L3 are bifilar wound on a ½" Teflon rod. The electrolytic capacitors adjacent to the filament transformer are part of a voltage doubler circuit used to operate the relay. The Muffin fan is mounted on the bottom plate.

equipment longer. Be sure the fan is operating whenever the filament is on. Warm up the tube for a few minutes before applying plate voltage. Never apply excitation without plate voltage or grid current may be excessive. Never operate the linear without an antenna or dummy load. Keep an eye on the tube, especially during testing and tune-up, and reduce voltage and/or loading if it starts getting red.

Let's first check for stability. Set C1 for about mid-range, adjust R2 to minimum value, interconnect exciter and linear with a length of RG8-U but don't apply excitation. Turn on fan and filament, apply approximately five hundred plate volts and, while watching the output meter, vary C10 and C11 over full range in various combinations. There should be no evidence of output and grid and plate meters should remain stationary with the grid meter possibly just off the peg and 20 to 25 plate mA. Increase plate voltage to operating level and go through this test again, being ready to cut the power if there is any meter movement. With 2000 plate volts you should have just a suggestion of grid current, approximately 60 plate mA and no output. Sit back and rest a minute—you were just gambling with a thirty-four dollar tube.

For final testing and tune-up you must have a dummy load. If you're new to linears you'll want to spend a lot of time learning to handle the beast and it's best to keep these struggles off the air. A scope is real handy to check linearity but it's not absolutely essential. So, connect the dummy load, cut back to about 500 plate volts, advance R2 as necessary to keep from pegging M1 and, with C10 and C11 at full mesh, apply excitation—somewhat reduced if this is convenient. At this level of operation you can be reasonably sure of not doing much damage.

Both grid and plate current will climb when excitation is applied. Reduce the value of C10 to give the maximum reading on the power output meter. Adjusting C11 will now increase this output. What we're striving for, now and forevermore, is *maximum power output with plate current three times greater than grid current*. If you don't have this ratio, increase the capacitance of C10 slightly and decrease the capacitance of C11 to peak the output. Continue this until the 1:3 ratio is achieved. Now, if you'll decrease the value of C11 just enough to drop the output by two or three percent, your amplifier should be linear. Its output should look and sound like a giant version of the input. During this tune-up you should pause to adjust C1 to produce maximum grid current indicating that your input L network is tuned to resonance. Now you're ready to gradually increase excitation and voltage, bringing the TUNE and LOAD capacitors back to resonance with each change. Keep an eye on the tube and retreat a little when it starts showing color.

This tuning technique is one which has been treated casually if at all in amateur publications. It's extremely important if you are to put a good signal on the air. Once you

learn how the controls interact it goes quickly and smoothly. Now is the time to experiment and here are some general observations. They'll help you arrive at a 1:3::grid current: plate current ratio at maximum power output for the combination of excitation and voltage you're using. Increasing excitation and voltage will increase the power output of your linear; however, you probably will not run wide open all the time. Increasing the excitation should increase grid current, plate current and power output. Increasing the voltage should decrease grid current and increase both plate current and power. As LOAD capacity is reduced TUNE capacity must be increased to reach resonance as indicated by maximum output. It is the interaction of these two controls which enable you to achieve the necessary 1:3 ratio for linearity. It is the interaction of excitation and voltage which determine your output level. Increased excitation will require higher TUNE capacitance and lower LOAD capacitance. Increased voltage will require less TUNE and more LOAD capacitance. This isn't nearly as complicated as it sounds. With a bit of practice *off the air* it'll become automatic.

Let's take one brief look at this matter of efficiency. With about thirty watts of excitation from a Thor transceiver and 1250 plate volts the linear pictured draws 225 plate milliamperes when properly tuned for 280 watts input. Its output into a Cantenna is one hundred watts with no modulation. With a steady 100% tone modulation the output jumps to 190 watts! This tends to support the proponents of AM linears who claim very impressive efficiency with modulated signals. With 1500 plate volts and 230 plate mA we have 345 watts in and about 132 watts out. Put 2000 volts on the plate and it glows dully as it should while drawing 240 mA. Output into the Cantenna goes to a little over 190 watts. It looks like efficiency increases slightly with increased power but modulation boost suffers. At the 2000 volt level modulation only kicks the output forty more watts. Maybe the metering is not too accurate or maybe we don't have enough excitation for peak power output but these figures offer some idea of what to expect from this critter.

What's important is the fact that for approximately one hundred bucks (plus a power supply) you can push your medium power AM signal right through the ceiling with no more operating problems than you have with your exciter. And when you eventually go six-sideband this linear with no modification will take you to a kilowatt.

. . . WA9IGU

James Ashe W2DXH
RD 1
Freeville, N.Y.

James Dandy Mixer

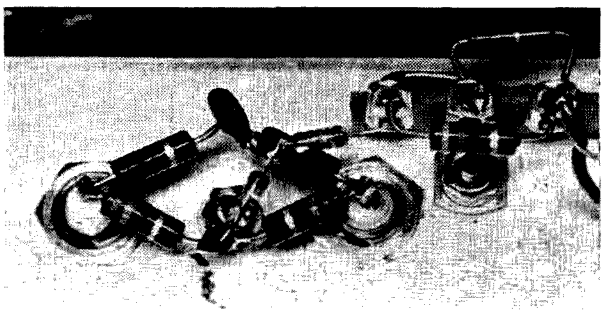
What basic circuit belongs on the amateur's workbench next to the RF signal generator, the frequency standard, and the dip oscillator? Ans: James Dandy Mixer!

Two frequently performed and closely related tests are the measurement of frequency and the general assessment of stability and quality of an RF signal. Both tests usually involve mixing a good RF signal and a questionable RF signal for an audio output, and judging the result. These tests are often performed with the aid of an old receiver which may not be able to give a good test. Or perhaps it won't tune the required range, or is simply not available. But the receiver isn't required. Better results can be obtained without it!

The following circuit is useful from high audio to the VHF range. It is simple, reliable, and can be assembled very inexpensively. Its value to the user is limited only by his ingenuity and understanding of the basic principles and facts involved. Enough recommendation.

Theory

Fig. 1 shows the entire schematic of the circuit, as mounted on an R/2 (half rack) panel. There are two parts to the circuit. The first is a simple resistor network which brings the two inputs to the detector input (LH side of 22pF) in such a way that neither input is much affected by the other. The other is the detector, which provides the nonlinear mixing required to bring out the audio difference beat, or to bring up the audio signal in a single RF input. Let's examine these one at a time.

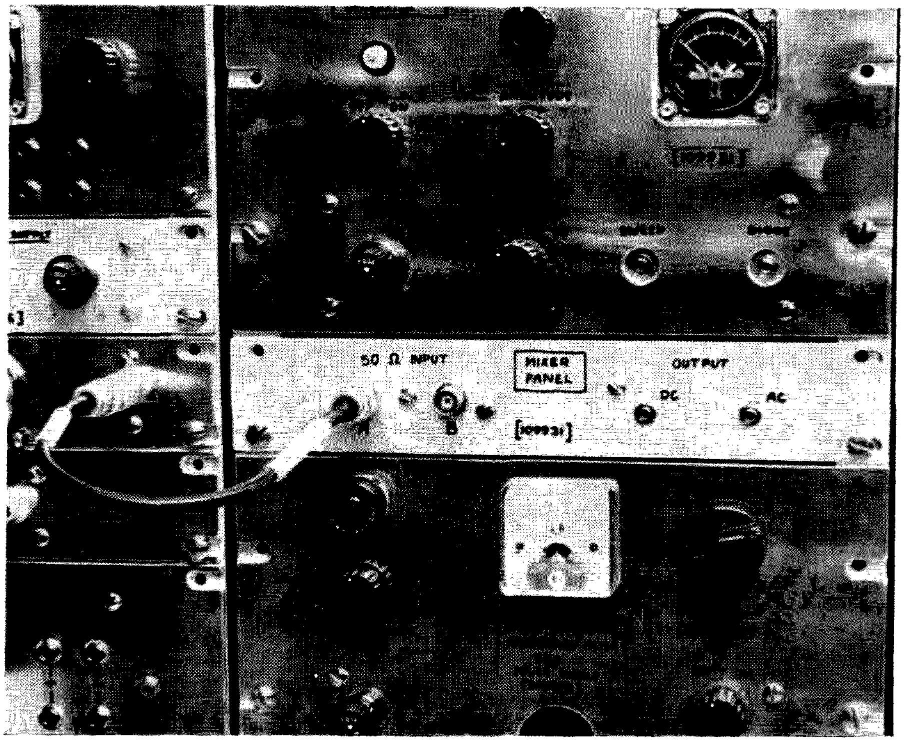


RF portion of the mixer. Note short leads and simple, open layout to minimize parasitic inductance and capacitance.

Why not tie the same piece of wire to both BNC inputs and hook the detector onto it also? Wouldn't it work? Yes, after a fashion, but if you hook two oscillator circuits together in this way, they'll fight. Since they will be trying to lock frequencies, any assessment of the individual performance of either one of them will be uncertain. Of course, you could use buffer amplifiers if you wanted to put up with the additional parts and reduced frequency range. But the resistor network is preferable for general purpose test work.

The books tell how to work out the behavior of simple voltage divider circuits. A little math will show that if you look into terminal A with terminal B open, you will see a 54 ohm load. If you short B to ground, the load at A falls to 52 ohms. Small change! With B open, 63% of the input at A appears at the detector; with B shorted this falls to 50%. Again, not a very great change. This all works out very well indeed if you want to test an oscillator without making up a lot of additional circuitry.

The diode detector action is also simple. As a mixer, the picture is not quite so clear, although by no means complicated. Suppose there are two RF signals whose frequencies are different by one cycle per second. What this means is that once per second both signals will come to a crest at the same instant, and add up. Halfway between these intervals the signals will go to a maximum opposition or interference. In the remaining time between these intervals the sum or difference is building up or decreasing. The detector sees



James Dandy Mixer goes nicely into the test panel with other half-rack gear.

the two signals as one, modulated by the difference rate, and that is what comes out!

Construction and use

This circuit is too simple to be hard to build. If the parts are good, it will work. But the greatest useful frequency can be raised by good VHF construction techniques: small components, short leads, minimum capacitance between components and to the chassis. The R/2 construction illustrated is generally used in locally built gear, and no shielding is visible because none was used. It doesn't seem to be required.

The apparent sensitivity of the mixer depends on the amplifier following it. Its voltage loss is not great, and most of the small RF voltages found in breadboard small-signal circuits are apparently considerably greater

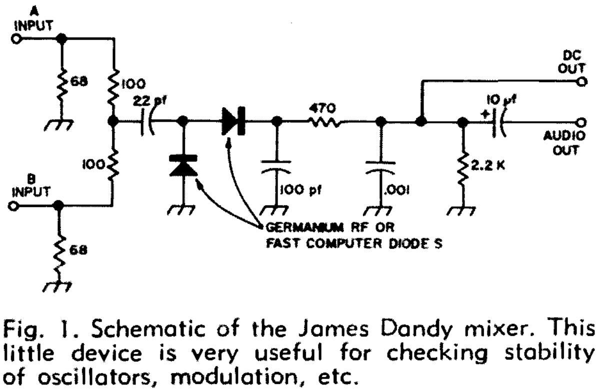


Fig. 1. Schematic of the James Dandy mixer. This little device is very useful for checking stability of oscillators, modulation, etc.

than some amateurs believe. The mixer is generally followed by a simple Lafayette audio amplifier, #99R9037 in their catalog #660. This amplifier offers adequate gain for listening to anything that can be shown to be oscillating, without much load on the oscillator. Its frequency response is zilch at low frequencies and one of the hi-fi type amplifiers might be desirable for some applications. Here are some illustrative examples.

Application #1. What is that new little oscillator doing? The tiny one, 1 mA at 3 volts? Attach signal generator to one input, hang a piece of wire from the other and bring it near the oscillator. Tune for beat, and listen. There is sufficient gain that you can ignore the mismatch. Ditto for calibration of the oscillator.

Application #2. Want to find leak in shielding. Signal generator to one input, piece of coax with pickup loop to the other input. Check for beat note, seal up the enclosure, and start searching.

Application #3. What does the modulation on the RF sound like? Pipe the RF into either input and listen.

Application #4. How well is that multiplier working? Pipe the RF to either input and put a meter on the DC output terminal.

Additional applications as required. When you have built and used one of these James Dandy Mixers, you will wonder what you did without it! . . . W2DXH

Donald Nelson WB2EGZ
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A Poor Man's 220 Transmitter

Here's a simple, inexpensive transmitter for the beginner on 220 MHz. Output is only half a watt, but that can work a good distance.

Inexpensive, low power transmitters have gained popularity through proven performance on 6 and 2 meters. "Why not find just how little is needed on 220 MHz?" I thought. Perhaps it was a foolish thought—for many failures followed.

The 1¼ meter band borders on UHF. This tends to complicate circuitry. Tuned lines were not considered for the tuned circuits, but it became evident that the coils and even the wiring looked somewhat like tuned lines. Tubes—especially receiving tubes—are not efficient because interelectrical capacitances are too great. Sometimes chokes and capacitors become self-resonant, making the circuit inefficient or even inactive. Hopefully, you will be spared this grief because here is a circuit that works! It has a plate modulated straight-through final which is stable, yet simple to construct. The project should be particularly attractive to the newly-licensed technician.

Circuitry

Only two tubes are used in the RF section of this transmitter (see Fig. 1), a 6GH8 and a 12BY7A. With a triode oscillating at 73.34 MHz, the 6GH8 triples in the pentode section. The oscillator multiplier is a modified Butler circuit which satisfies the low drive limitations of the overtone crystal. A 6EA8 may be used in place of the 6GH8 if you wish. The 220 MHz output of the multiplier is RC coupled to the 12BY7A final which is screen neutralized. Incidently, the 12BY7A holds its own place among receiving tubes for low 220 MHz drive requirements. It is not efficient, but it works with upward modulation and is easily neutralized.

Let's talk about crystals for a minute since this application may be controversial. In a transmitter oscillator, the crystal is not only a frequency source, but a power source. The oscillator may be viewed as an amplifier using the crystal as the driving element in the manner of any conventional large signal RF amplifier. Now, if the amplifier has a fixed gain of 10, the output of the circuit will be 10 times the drive level of the crystal. When the crystal is driven hard, the output is propor-

tionally greater. An 8 MHz crystal may be driven at 5 to 10 milliwatts without harm, but overtone types (20 MHz and higher) must be limited to a 1 or 2 milliwatt level. For this reason, the overtone oscillator will have an output power of 1/5 that of the fundamental oscillator. In transmitter applications, additional gain will usually be required to achieve a useful output level.

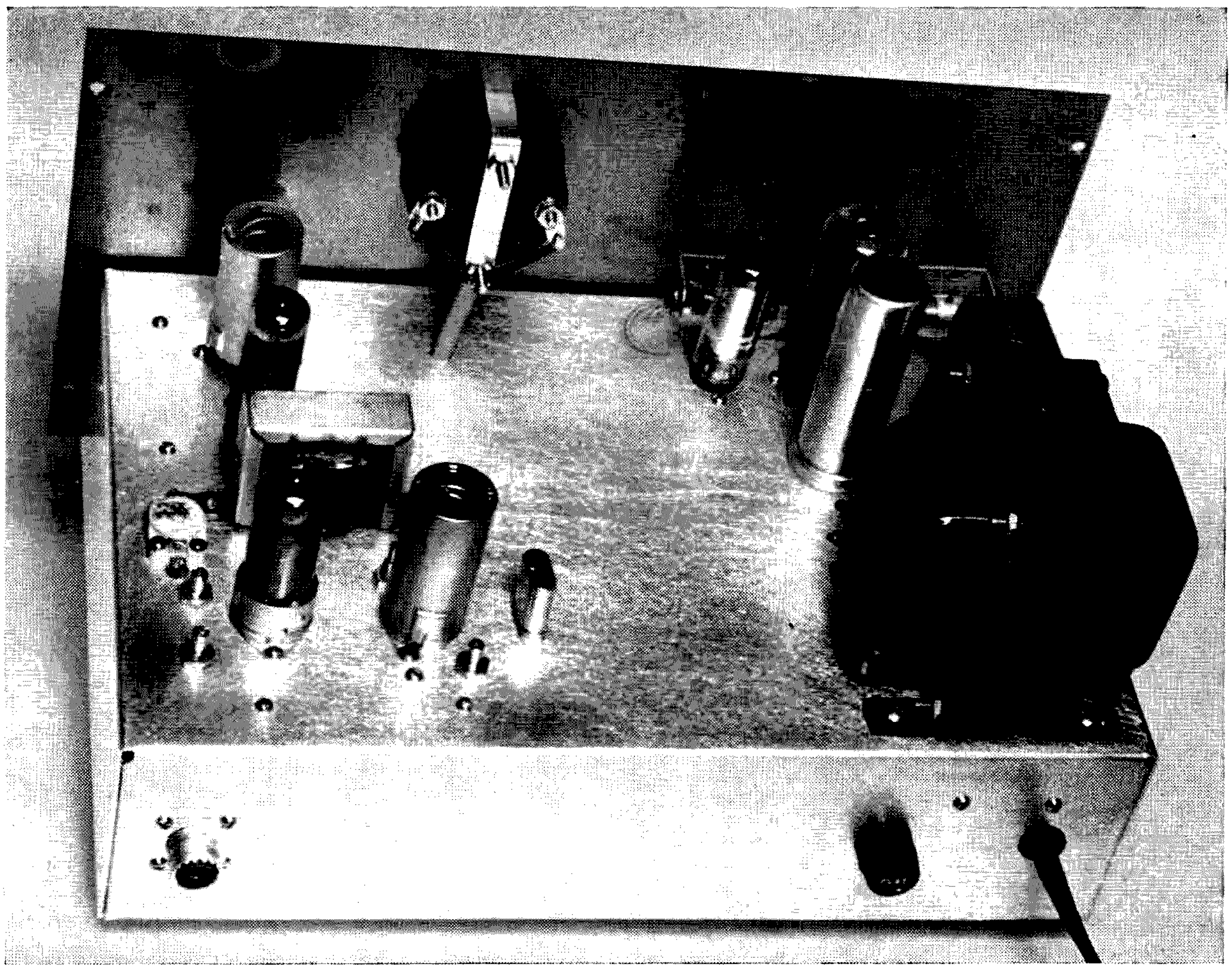
What happens if the overtone crystal is overdriven? The crystal may fracture, but more likely will be the increase in spurious responses and possibly some instability of the crystal. In the case of a transmitter, several spurious outputs at frequencies a few Kilohertz from the main carrier will be noted. In converter applications, the overdriven crystal will produce image and "out of band" reception.

Experiments with different oscillators and controlled crystal drive levels showed the Butler oscillator to be the least critical. Using a pentode in the multiplier section provided sufficient gain to drive the final PA without additional amplification.

There is nothing magic about the modulator. A two stage voltage amplifier (12AX7) is followed by a 6AQ5 power stage. Chokes in the heaters and the microphone input are used to suppress RF feedback. The modulation transformer T_2, has a slight mismatch, but more than enough audio is available to compensate for the transformer loss. While a specific transceiver transformer is called for, the system works well with any 10 W universal output transformer.

For those who prefer solid state rectifiers, any units rated at 100 mA and 1000 PIV or greater would be fine. A word of caution might be in order. Silicon rectifiers have fine efficiency, but will not stand the voltage overload as a tube will.

Actually, the only frills on this whole unit are the case and the plate current meter. You don't need either, but your wife will be impressed. Costs of both items are very reason-



Rear view of the Poor Man's 220 transmitter built by Gene Jackson WB2CVF. His transmitter, which is shown in all of these photos, is the most photogenic of the transmitters that were built. Note that room was left for a simple receiver in the center of the chassis.

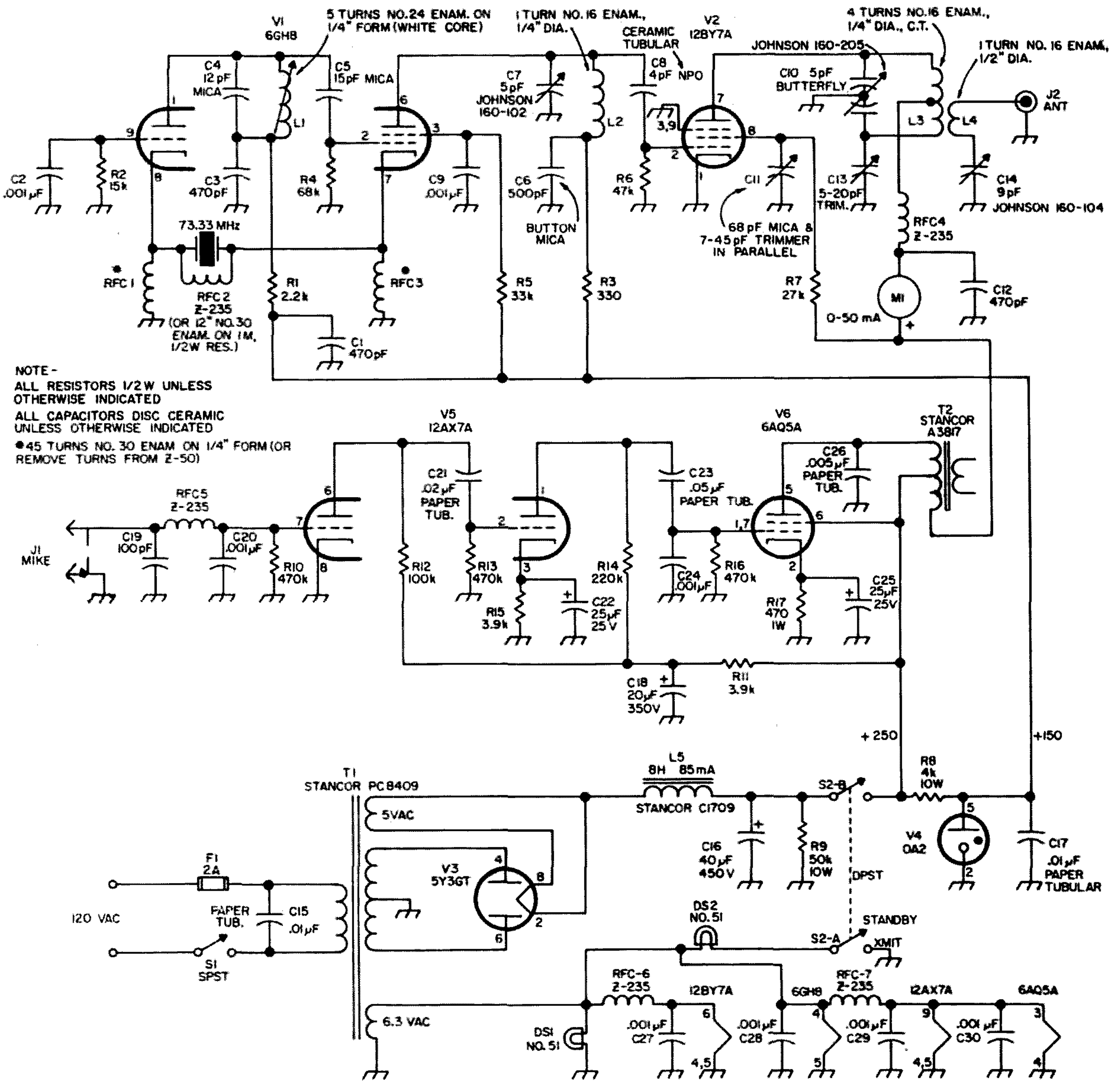


Fig. 1. Schematic of the Poor Man's 220 MHz transmitter. Output is 500 mW with 5 W input. This isn't exactly overpowering efficiency, but the transmitter modulates upward and gives excellent local coverage.

able. If a final grid current meter is desired, a 100 µA or 200 µA meter would be suitable. Those values don't come in the low cost variety, however. Grid current runs near 75 µA.

Construction details

All components are mounted on an 8 x 12 x 3 aluminum chassis which is later housed in a Bud "Shadow Box." Chassis layout is shown in Fig. 2. A nut is placed between the chassis and front panel on the two switches and the microphone jack to accommodate the mounting flange. When the chassis was installed in the shadow box, spacers had to be used to raise the whole chassis for alignment with the recessed frame. Shields were used on the 12AX7 and the 6GH8, but should not be used on the other tubes.

The layout of the RF section is the only critical part. Keep RF leads as short as possible and avoid unnecessary kinks in the wire. The parts layout of the RF section has been used on three transmitters with some small variations. All units produced the same results. One of the units is on a 17 x 5 x 2 chassis which was rack mounted. The original construction (only the RF section) was made on a 5 x 7 x 2 chassis. Such an idea may appeal to anyone with a separate power supply and modulator.

There is sufficient room on the chassis to add a receiver, if desired. The modulator could be switched for receiver audio. First thoughts on a receiver are to build a superregenerative type with a broad grounded grid RF stage. A converter, used with a superhet is the best path to take, but a bit large for

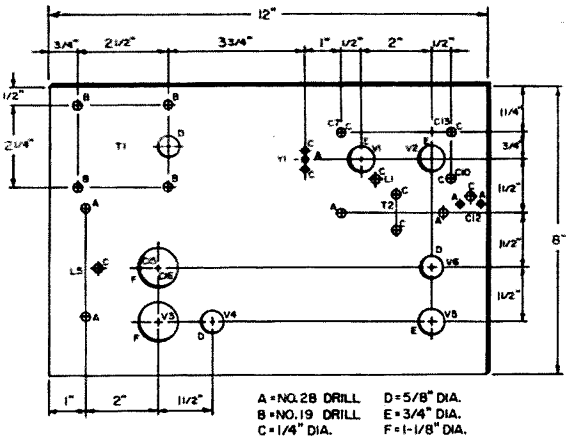


Fig. 2. Layout of the chassis of the Poor Man's 220 transmitter.

the correction. Now replace the crystal and readjust C_{10} in conjunction with C_{13} to find maximum output. C_{13} is now permanently adjusted until a new final tube is needed. Recheck neutralization, then adjust C_{14} for maximum output. Peaking of C_7 and C_{10} may be necessary. The procedure may have to be repeated several times, but once neutralization is achieved, C_{11} should not require readjustment unless the 6GH8 or 12BY7A is replaced. At optimum tuning, measured power output was 500 mW, modulation was upward, and the removal of the crystal cutoff the RF completely. The plate current is 20 mA giving a 5 W input rating. If frequency shifts during operation or spurious responses are noted, L_1 should be adjusted.

On the Air

One-half watt is Q5 at 30 miles if reasonable antenna systems and a good receiver fill the gap. (Gene, WB2CVF, holds the record of 64 miles with this transmitter.) We grant that 10% plate efficiency is nothing to brag about, but the 12BY7 performs better than several other tubes which were tried. The audio quality is excellent with 100% modulation possible. TVI is not present at the author's location. High output microphones can overmodulate the transmitter. As a builder, you might prefer to make R_{10} an audio gain control and limit peak modulation. No reduction of the voltage amplifier's gain was shown in this schematic in order not to limit the ham who has a low output microphone.

In all, the Poor Man's 220 Transmitter satisfies all its objectives. If you are a poor man, why not build one for the fun of it? You will be a little richer by the experience.

The author wishes to thank Steve Wojcik for the photography.

. . . WB2EGZ

E. Cazelais VE2DG
1666 Massenet,
Chomedey, Quebec.

Another Solid State 2 M Transmitter

This simple transmitter uses inexpensive transistors for 150 mW output on 144 MHz.

The transistorized transmitter described herein was intended primarily for remote control of models but hams being what they are, the transmitter was quickly modified for short range communications on 2 meters.

Referring to the schematic, readers of 73 will recognize the oscillator-multiplier described earlier by Bill Hoisington K1CLL. Slight changes to the position of the feedback tap on the oscillator tank coil and different values of emitter resistor and tank circuit constants of the tripler stage were found necessary for best results with the type of transistor used.

The output stage uses a 2N3564 which is characterized for low level operation but with a typical F_T of 750 MHz and collector dissipation of roughly 0.3 watts with a heat sink it makes a dandy power amplifier. The input power runs approximately 35 mA at 12.4 volts for

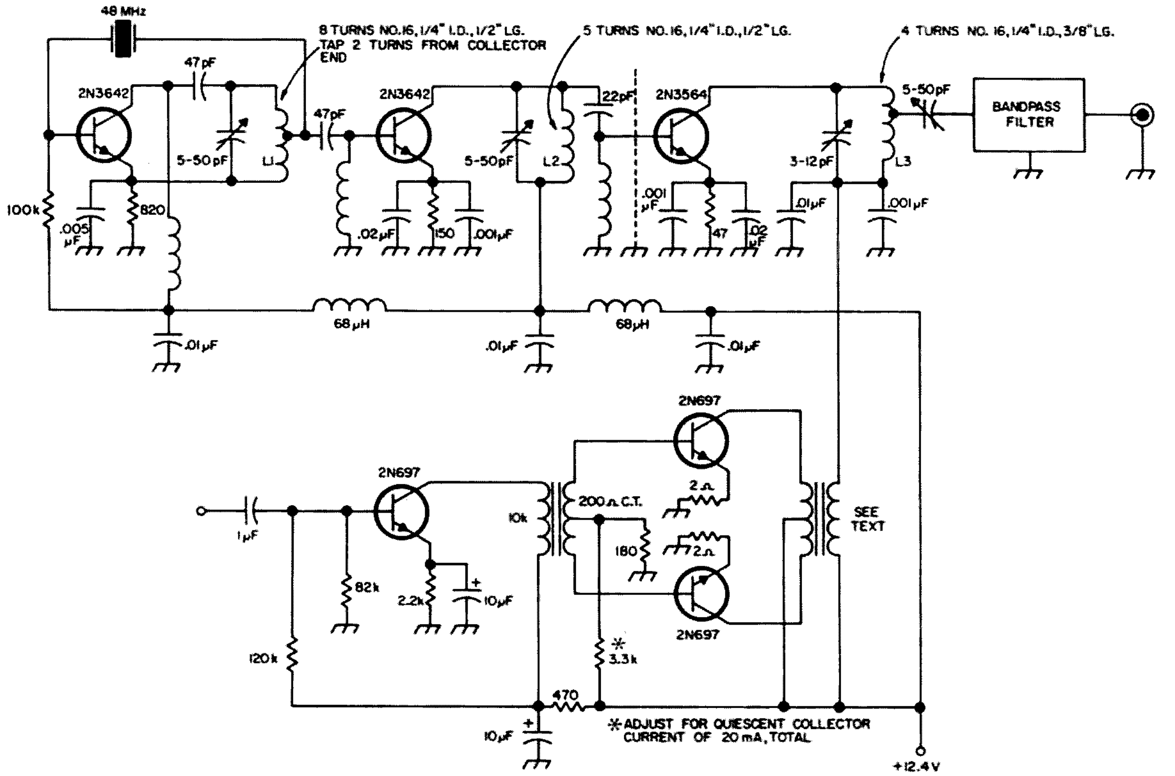
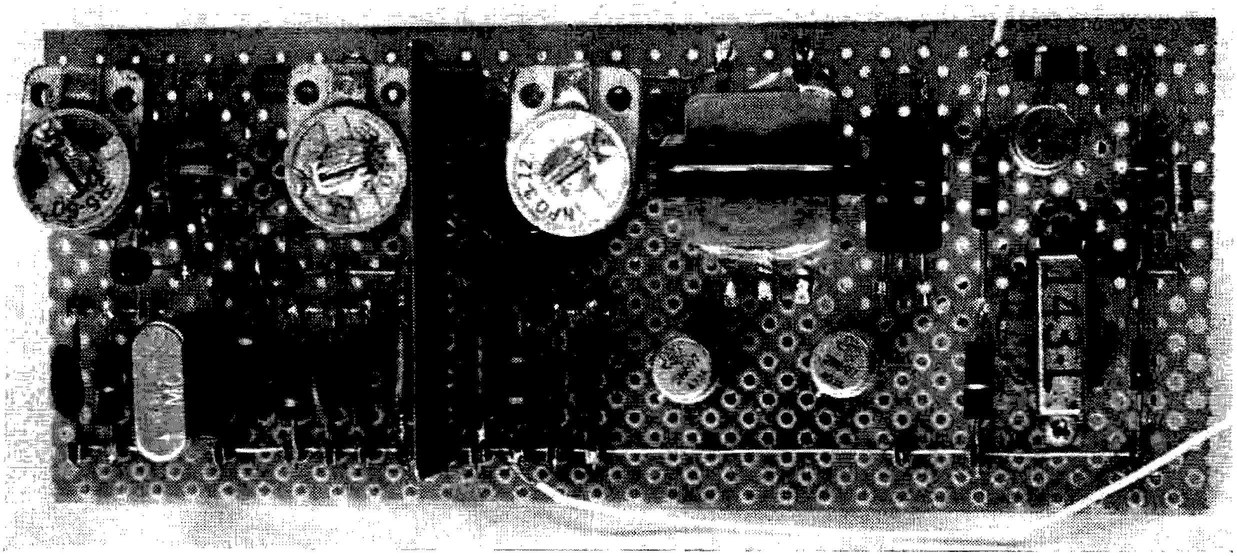


Fig. 1. Schematic of VE2DG's simple two meter transmitter. All of the transistors used are inexpensive. The unmarked RF chokes are ones suitable for the frequencies involved; Z50 for the oscillator and driver and Z144 for the final base. You can make your own from ¼ wavelength of thin wire wound on a large value resistor.



The two meter transistor transmitter is built on a small sheet of perforated board. The modulator is at the left, the power amplifier in the center, and the exciter stages at the right.

an output of 150 mW. Interstage decoupling and emitter resistor by-passing was found to be most important and the imposing number of by-pass capacitors is not fantasy, every one helps in getting the most out of every stage. Proximity of L_2 and L_3 on the finished transmitter resulted in interaction between multiplier and power amplifier but the addition of a copper shield between the two stages cleared that problem very effectively. The limited amount of filtering obtained with the small number of tuned circuits resulted in severe interference with channel 10 but was quickly dealt with by the addition of a filter in the antenna lead and since the transmitter is totally enclosed in actual operation, TVI is effectively eliminated.

The modulator is quite conventional except for the modulation transformer which is home brew, none being available commercially.

The design approach for the transformer consisted in adjusting the turns ratio for 100% modulation and NO MORE, since oversize modulators have been known to destroy many good RF transistors.

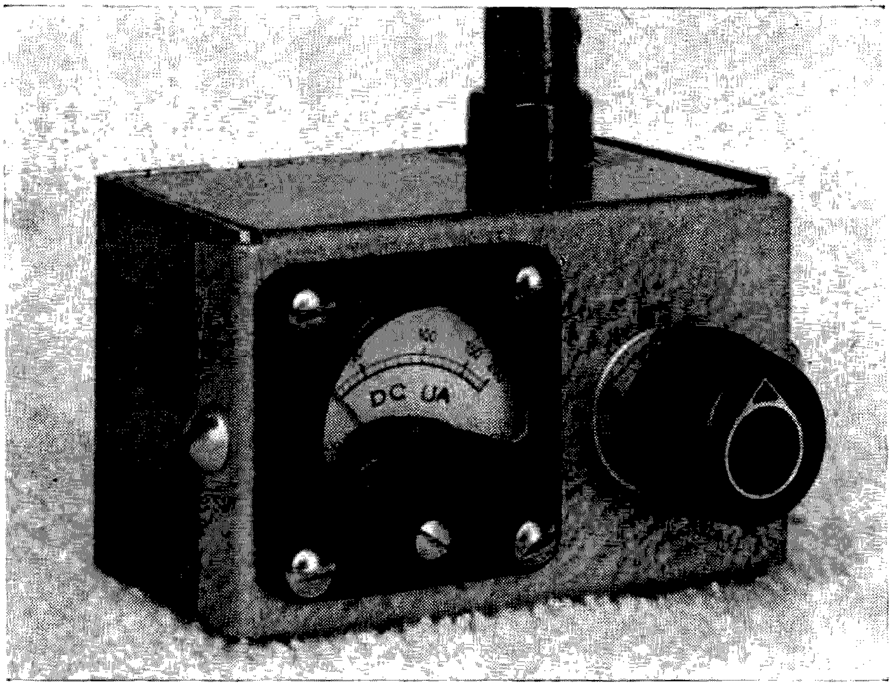
The core was obtained from a stripped down audio transformer having a center leg width of ½" and stack height of ½". The primary is wound with 405 turns of #30 bifilar, (This helps equalize the losses) and the secondary is made with 460 turns of #30. The core is assembled with the E's and I's butting against each other with a piece of cigarette paper in between.

The turns ratio given is just enough to modulate the output stage 100%; above this level, the modulator starts clipping but even under these conditions the collector breakdown voltage of the 2N3564 is exceeded. So far, the transistors used in the output are still alive after 25 hours of operation, (they sure make better transistors than they used to) nevertheless, the use of a 50 volt transistor is strongly recommended.

The audio pre-amplifier shown has enough gain to modulate the transmitter fully with an input of less than 1 mV, allowing use of low output crystal or dynamic microphones.

The modulation transformer shown in the photo is for frequencies above 1 kHz and is therefore much smaller than the one described in the text. Picture was taken before modification for voice communication.

. . . VE2DC



Don Smith W3UZN
P.O. Box 45
Hagerstown, Md.

The Mini Monitor

Build this tiny field strength meter and know what power you're putting out.

Turn on a transmitter, let it warm up, hit the transmit switch, dip the final and out goes maximum signal. Or does it? Unless you are very familiar with electronic gear, you may not know that that isn't necessarily true at all.

Any tube which may be used as the final amplifier in a transmitter, other than a triode, does not necessarily produce maximum RF output at the same tuning point as minimum plate current. Of course, if the plate is dipped, safe tube operation will result, but why not get maximum output? What it takes to do the job, is a signal strength meter—the Mini Monitor.

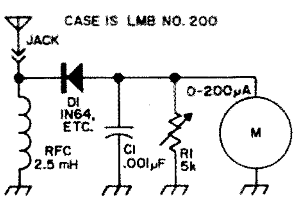
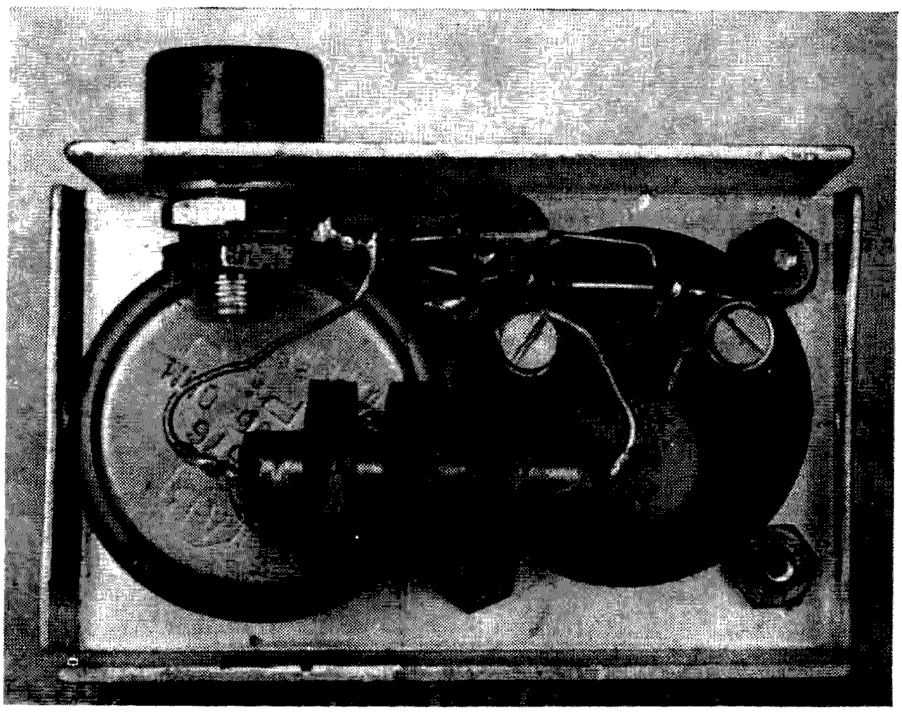


Fig. 1. Schematic of the Mini Monitor.

Such a meter is of great value in mobile operation. It really doesn't matter how much power your running, either, as you want maximum output from your rig. Space for electronic equipment in a car has always been a problem, and if you have a VW like the author, or a Porsche, like Wayne, WOW is space ever at a premium! With this in mind, I sat down and designed the smallest signal strength meter that could be built, using readily available parts.

The tiny instrument is less than 2¼ inches long, 1½ inches tall and 1⅜ inches deep! Though extremely small, it has all the advantages of much larger instruments. A sensitivity control is mounted on the front panel, next to the 1" meter, so that strong signals will not damage the meter. A banana jack is mounted on top, permitting the antenna to be plugged in when the unit is in use. At other times the unit can be placed in the glove compartment, as it won't take up much room in there, even in a Volkswagen.

The circuit is straight forward, with a radio



Back view of the Mini Monitor. The one inch meter is from Alco in Lawrence, Massachusetts.

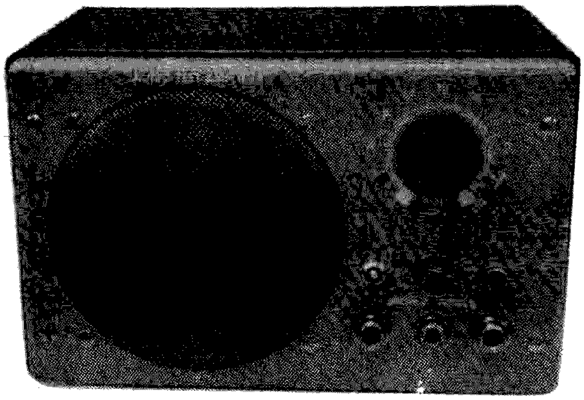
frequency choke used to develop the incoming signal across, from the antenna. The signal is rectified by a small diode, and filtered by a small disc capacitor. This small signal current then flows through the microammeter, causing a reading on the meter. The sensitivity control is placed across the meter so that the signal current flow through the meter can be controlled. On very strong signals, the sensitivity control is turned down, decreasing the resistance it places across the meter. This increases the signal current through the resistor, and thereby keeps current flow through the meter to the desired level.

An antenna for the unit can be made out of anything you happen to have lying around. An 18" piece of #16 copper wire connected to a banana jack was used on the unit shown. You could use a piece of piano wire, if you happened to have it, as it will stay straight and look like a miniature whip antenna! If you are using a transmitter with only a watt or so output, you may find the meter not sensitive enough. If so, increase the length of the antenna slightly.

Place the unit on your dashboard, or hood of the car, as this location makes it easy to watch the meter as you tune the rig. When you tune the rig for maximum reading on the Mini Monitor, you can be sure that you are putting out the greatest signal your rig can. Use the Mini Monitor for tuning up and adjusting antennas too. As you make adjustments, always work towards increasing the reading on the Monitor, without changing its location. Once you build and use this Mini Monitor, you'll never want to be without it!

. . . W3UZN

Ronald Vaceluke W9SEK
17 W 540 Hillcrest
Wooddale, Illinois



Audio Test Amplifier

Simplify your experimenting with this handy instrument.

How many times have you wished that you had a small bench amplifier? I know of many times in the past that I have had to use earphones and a blocking capacitor to check audio circuitry just because of the fact I didn't have an audio amplifier on the bench. But not again! I finally made my mind up that I would do something about it and thought I would pass this along.

The requirements were:

1. Low cost.
2. A relatively high input impedance.
3. Sufficient gain to drive a speaker.
4. Transistorized (no warm-up time).
5. Self-contained.

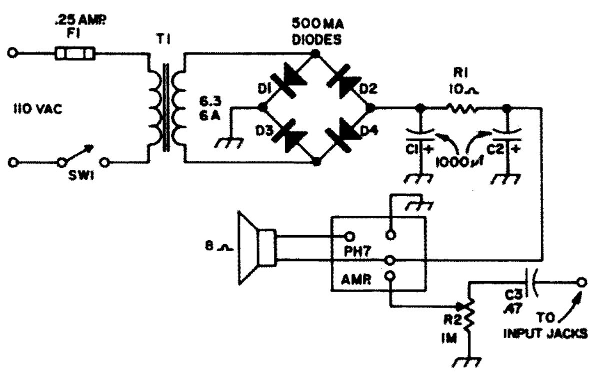


Fig. 1. Schematic of the audio test amplifier. The amplifier module is a Carl Cordover and Co. PH-7 or equivalent. Lafayette sells similar modules.

The first four requirements were met by using a commercial amplifier module and merely packaging it with a few other items into a neat package. The "other items" include input jacks and gain control, a power supply and a speaker. I used six input jacks of different configurations in order to make the unit more versatile. Any number and type of jack can be used and the choice is up to the builder.

The power supply simply uses a filament transformer with bridge rectification and filtering. The filter has an RC pi network which is relatively effective in smoothing out the voltage; however, there is still a small trace of hum. This should not prove to be a handicap unless you are trying to use the amplifier for tracing down low level hum. A more sophisticated (and expensive) power supply would then be necessary. Of course batteries could always be used but this gets to be expensive if the amplifier is used a great deal because of the rather large current that is drawn by the module.

The amplifier shown was built in a Bud CU-585 cabinet which gives a neat commercial appearance and matches by other home brew test gear. If economy is a prime consideration, a lower cost Mini-box can be used. The front panel holds all the components of the unit. The speaker grill (64B890458) shown is avail-

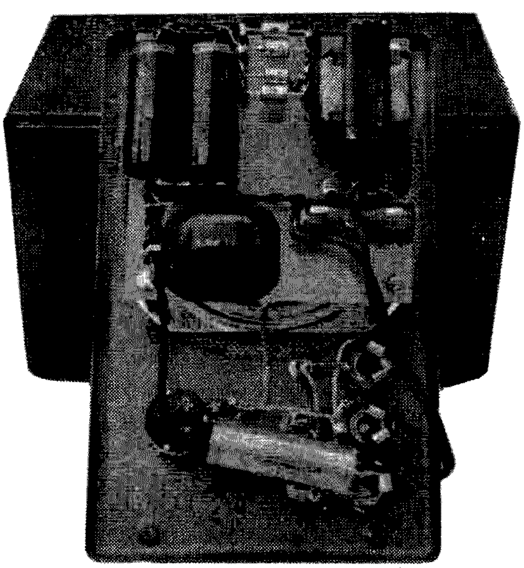
able for $1.80 from Motorola, 4910 W. Flourney, Chicago, Illinois, and dresses the amplifier up. The only draw-back with this is that a large hole has to be cut out of the panel and may present a problem to someone that hasn't access to the proper tools for this job. An alternate method is to drill a series of holes in the panel to pass the sound from the speaker.

The module and power supply were built on a piece of 3⅞ x 3⅞ glass epoxy board that was handy, but a piece of perforated phenolic will work as well. This chassis is mounted behind the speaker by threaded bushings and secures the grill, speaker and chassis in a neat sandwich configuration. The mounting of the components is not critical; the only precaution is to keep the power transformer away from the amplifier module to keep hum from being induced into it.

After the wiring is completed be sure to check all connections for proper solder and lead dress. If all checks out then the unit can be connected to the line. When the unit is turned on a slight hum will be heard from the speaker and when a finger is touched to an input, a harsh buzz should be obtained. Now connect an audio device such as an audio oscillator or AM-FM tuner to the input. It should be heard with plenty of volume. Only one precaution must be observed and that is that no more than 400 volts DC can be connected to the input. This is determined by the voltage breakdown of C3.

Your audio test amplifier is now ready for many years of signal tracing, always ready the moment it is turned on.

. . . W9SEK



Inside of the audio test amplifier.

Wayne Cooper K4X.' V
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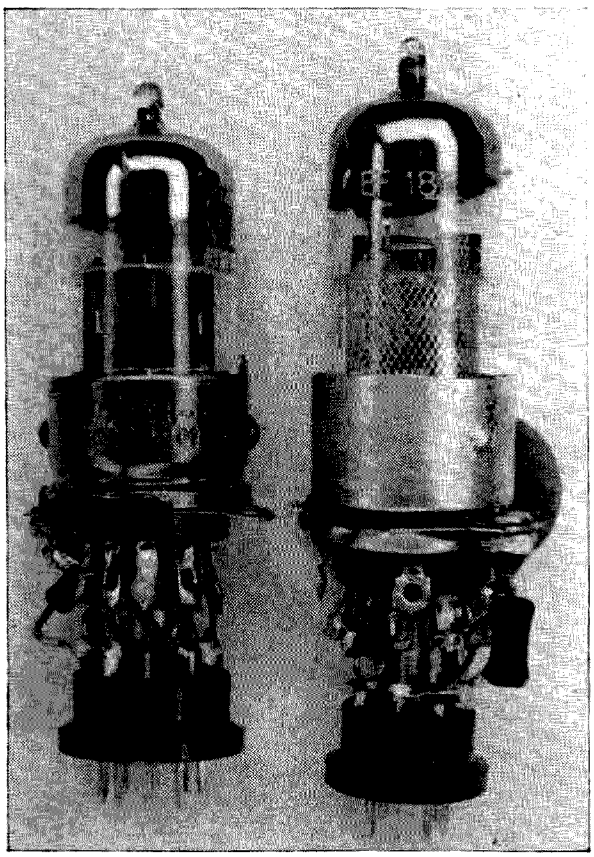
Miami, Florida

The Chicken Method

Many articles have been written over the years extolling the virtues of some new tube or circuit application to improve existing equipment. The reader is often told in glowing terms how changing tubes in the front-end of his receiver will boost the signals so many "S" units or that the DX signals will really pour forth. On-the-air contacts will boast such changes with authority to all who will listen.

Some tube and circuit changes that have made the rounds are well engineered and should be considered by the ham that wants the maximum results from his equipment. Unfortunately, unless the store-bought equipment is old enough to vote the average experimental-minded ham is reluctant to dig into the set if more than a direct tube replacement is indicated.



Bottom plug-in base. 9 pin—Eby TT-20 7 pin—Eby IT-12. Top socket Cinch 7-JC-2 7 pin or 9-JC-2, 9 pin. Drill out and remove center shield post for a 4-40 flat head bolt.

The photo shows the "chicken method" of modifying a circuit, changing the tube type or operating parameters of the existing one. These adapters are easily fabricated using the appropriate tube base plug and socket bolted together with a ½" spacer. Besides making the necessary cross-connections, the spacer and the tube socket shield are connected to ground to carry on the normal shielding and isolation. One or more adapters can be made up to cover the various tube or circuit changes. These along with the original tube can be rapidly plugged in and out under the test conditions or for an on-the-air check. After the evaluation has been made, the best adapter can be left in permanently if it is not desirable to make a more permanent change.

Personally, I have no qualms about turning the finest gear into a "prototype" if tests, not hearsay, can show that a worthwhile improvement will result. The use of plug-in circuit and tube adapters came in very handy recently in improving the front-end of an otherwise well designed commercial receiver. Hearing of a new front-end tube and seeing circuits for it in a planted article in a well known publication made it impressive, though not much when a not-so-glowing report was received from the manufacturer for this particular application. But I got a tube and others to be tested and made up adapters. With the tube in question, it was like leaving the noise generator permanently connected! Combinations of the new frame grid types cut the NF to one-third of that in the original circuit. After thorough testing, the receiver was changed permanently and only once. It would have been quite time consuming and messy to have made all of those changes in the set for each tube combination. Being able to switch back and forth with the plug-in adapters makes for more convenient and convincing testing. While their use may be the "chicken method" to some, it is also a handy tool for the serious experimenter too.

. . . K4ZZV

Walt Rogers W1DFS
24 Orient Avenue
Melrose, Mass.

Tubeless VFO for Six (or Two)

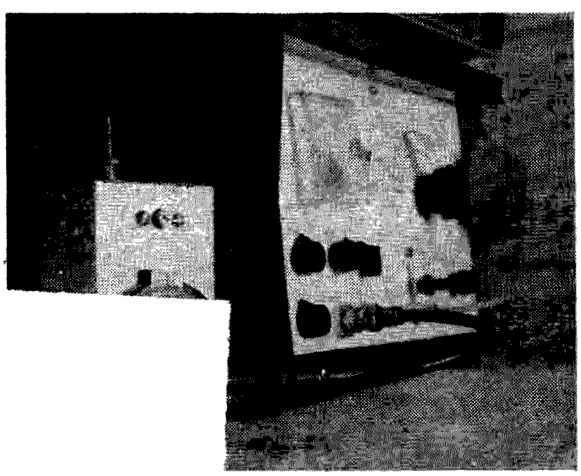
Why be satisfied with crystals when a simple tubeless VFO is so easy?

"I suppose I'll have to build a VFO with tubes or transistors so I can QSY at leisure."

Most of our rigs on six (or two) are capable of using a tubeless VFO. Many think that a crystal puts out power. A quartz, frequency-controlling crystal represents a capacitance and inductance having extremely high "Q" so as to be an excellent stabilized tuned circuit. It is in effect a large frequency controlling flywheel. While temperature has a minor change factor, and the tube (or transistor) has some minor loading, the high "Q" holds the frequency very close to the crystal mechanical radio frequency resonant vibration design. But power does not come from the crystal. The tube or transistor give the amplification power.

Thus if we simulate a crystal by designing an inductance and capacitance to resonate at our desired frequency, we can make a tubeless VFO using the present crystal oscillator tube. But this VFO must be designed ruggedly, and made to be re-settable to our needed calibration.

On the Gonset and Clegg transceivers and for six and two, we do not require the stability that is needed for sideband. And thus we can make use of simplified designs that make the construction much easier.


eeding a Clegg 99'er.

Looking at Fig. 1, there is a tuned circuit L1 with a variable capacitor controlled by a vernier drive dial, a band setting capacitor, which is variable, and a fixed mica capacitor so that the tuned circuit is rather high "C". The mica capacitor is choosen so that temperature will have minimum frequency effect.

Note also that the inductance L1 is wound on a form—ceramic in this case—so that the inductance will not vibrate mechanically and "sing" every time the unit is jarred.

Also I found that the use of the crystal socket on the Clegg, was impossible as it did not provide positive contact. Thus I used a BNC connector but for those who might not have a supply from surplus gear, the RCA audio plugs are convenient and adequate. The coaxial lead from the VFO to the rig should not be long—many suggest seven inches as a maximum—but this may be longer. I am using 15 inches. The shorter the better as this coaxial lead is a capacity loading across the frequency controlling tuned circuit.

First I mounted all the parts, keeping in mind short leads and rugged construction. This unit was rebuilt after making the mistake in trying to use a self-supporting inductance. The variable tuning slug was not needed, but as it was a part of the coil form. I did not remove it.

I found that 8 turns of 18 Formvar (enamel is ok) wire was about right so that the tuning capicitor covered the band from 10 to 80 degrees on the dial. Use a grid dip meter to regulate the band setting. The series mica and the cable, load the tuned circuit so that when they are added, the band setting capacitor is backed off a bit. It was felt that no connector

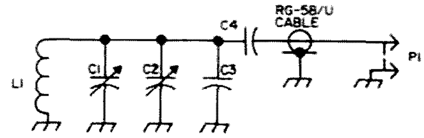


Fig. 1. Schematic of the tubeless VFO for six or two. C1 is the tuning capacitor, 3-25 pF with a shaft. C2 is the bandsetting capacitor, 4-50 pF. C3 is a 220 pF mica capacitor. C4 is a 150 pF mica capacitor. L1 is a 3/8" coil form with 8 turns of #18 Formvar on it.

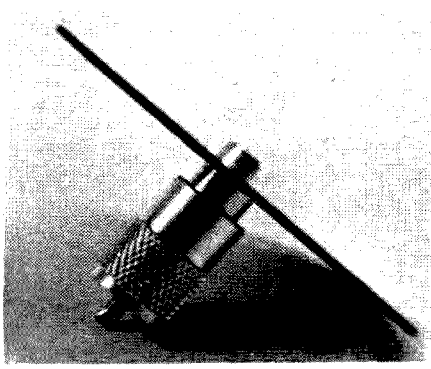
was needed at the unit, so that the RG58U was tied into the VFO and the outboard end was provided with the cable connector.

Note—for six meters the VFO should start on 12.5 MHz rather than 8.333 MHz a unit for two should be on 12 MHz rather than 8.000 MHz.

Before putting the rig on the air, I suggest that you try the unit running into a dummy antenna such as a suitable lamp, until you are sure you are stable and within the band. It is easy to pick up the 12.5 MHz signal on a general coverage receiver. I find that signals on the air drift more that the apparent drift of this VFO. A Collins 51J3 is a pretty good frequency meter—hi.

So good hunting—use what you have in your "junk box," and enjoy being able to zero in on a wanted station. With care, the tubeless VFO can be made stable enough to meet our requirements for six and two so as to add lots of enjoyment to our operation on these bands.

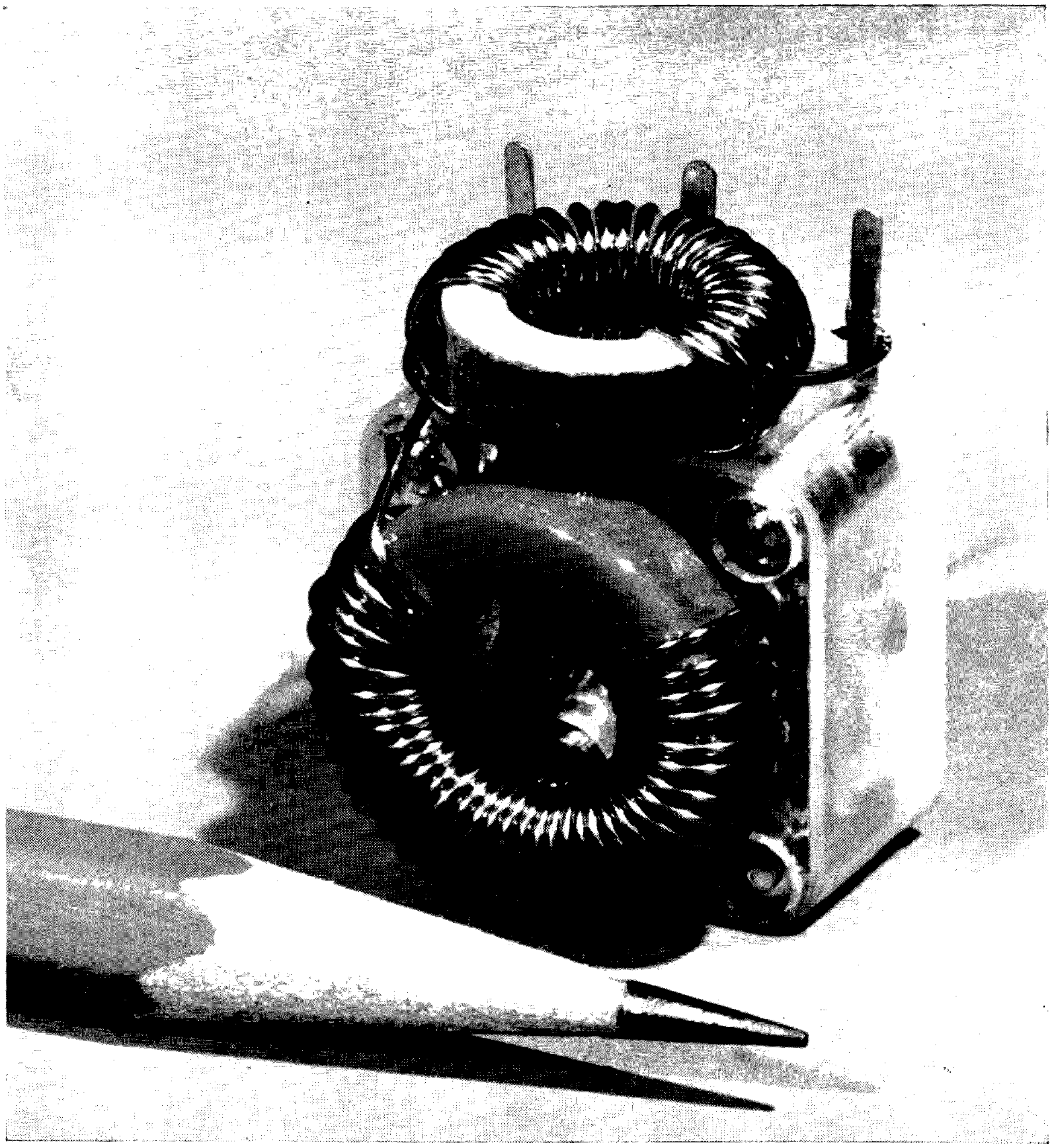
. . . W1DFS



Chassis Mounted PL-259

A chassis type male UHF connector can be improvised by using a standard PL-259 and an RG-58 or RG-59 adapter to go with it. Drill a hole large enough to pass the adapter, then pass the adapter through the hole and screw the PL-259 on from the other side of the chassis.

. . . Ed Morris WA2VLU



Joe Williams W6SFM
4150 Beck Avenue
North Hollywood, Calif.
Photo by Paul Bailey.

A Toroidal Multiband Tuner

Build this simple MBT and put it to many uses.

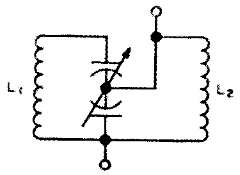


Fig. 1. Schematic of the toroidal multiband tuner. L1 and L2 are described in the text.

The advantages of the 80 through 10 Meter Miniature Multiband Tuner were detailed in the original article published in 73 for December, 1964. Here, the miniaturization is continued and the pass band is narrowed through the use of toroids.

Ham literature is carrying more and more articles about and references to toroidal inductances. To make a long story short: the toroid offers smaller size, higher Q and a more efficient transfer of signal energy. The smaller size is due to two factors. The component itself is smaller and there is no necessity for leaving a large space around the inductance to preserve the Q. This means that the stuffing ratio is improved because more parts can be packed within a given space. Toroidal RF transformers are more efficient because the magnetic energy remains in or near the center hole instead of being sprayed around the chassis. Thus more

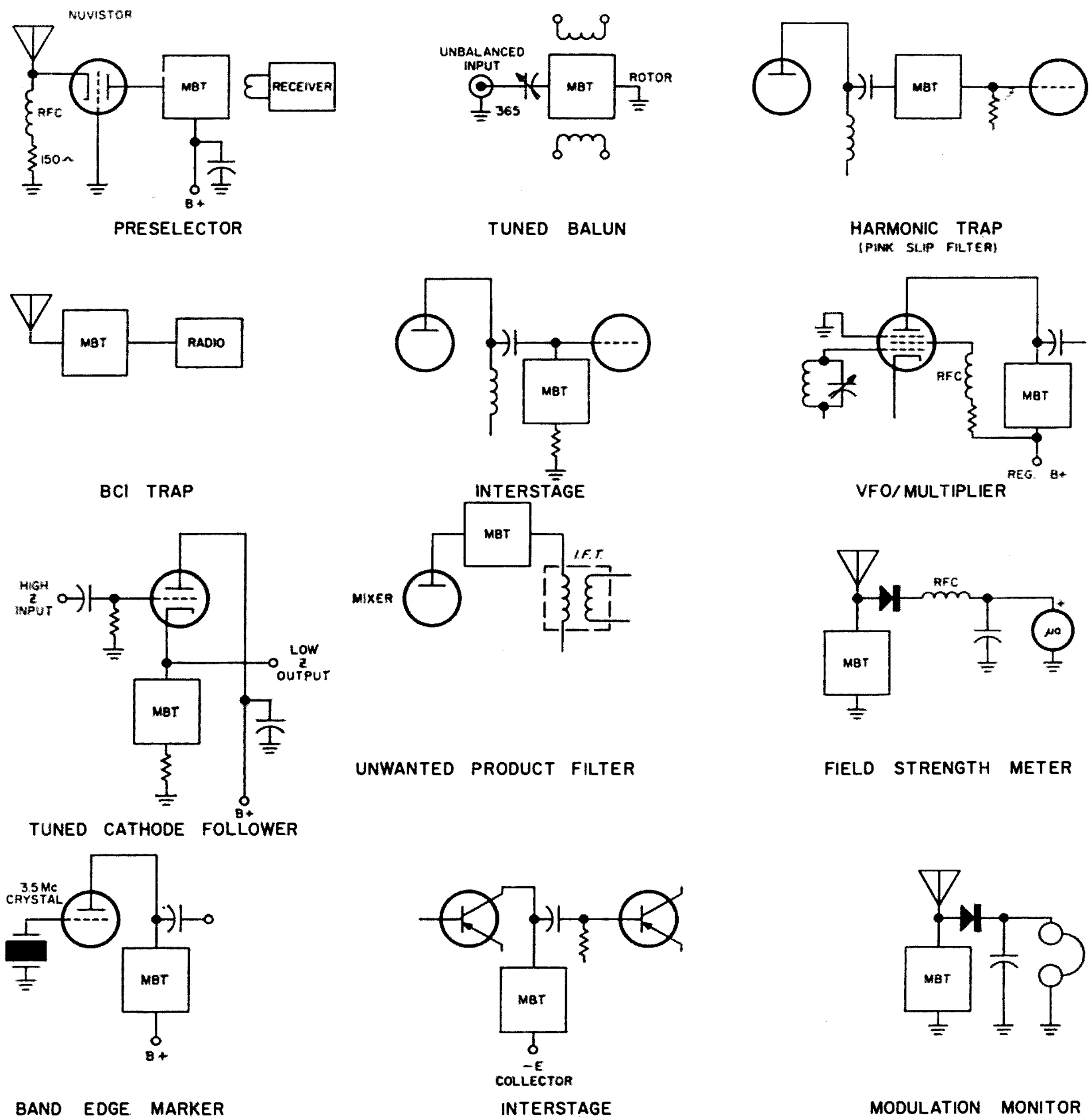


Fig. 2. Some typical suggested uses for the toroidal multiband tuner. See how many more you can think of.

signal is induced into the secondary and applied to the following stage.

The Q (z/R) of an inductance in a tuned circuit has a direct relationship to the width of the pass band of the tank. The average slug tuned inductance has a Q of about 80. RF Toroids of simple design will exhibit Q's of about twice that. The happy result is a pass band that is stopped down to a more narrow value than that of the conventional LC combination.

The toroidal multibander uses the same circuit plan as the original tuner with toroid equivalents of the air coils. The two section tuning capacitor (11 pF to 111 pF and 11 pF to 235 pF) is a CalRad CR 201 which is widely available. L1 is 23 turns on a .50" HF/VHF core of mix 'SF" and L2 is 34 turns on a mix "E" HF core. The wire size is #24. Both cores and the wire are from an experimenter's kit marketed by Ami-Tron Associates, 12033 Otsego St., North Hollywood, Calif. 91607. The smaller inductance is Duco cemented to the top of the capacitor with an unwound gap left at the back so that a link can be added if so desired. The blank spot on the L2 "E" core is positioned opposite the L1 gap to minimize the possibility of inductive coupling.

The easiest way to calibrate the tuner is with an all band receiver because the energy confinement to the hole of the core is so pronounced that it's hard to get a grid dip reading on a small toroid. The tuner is just connected between the receiver and an antenna. When the tuner frequency coincides with that of the receiver the incoming signals will be notched way down in amplitude.

Color	Letter	Numeral	Spectral Range
Green	HA	41	Audio to 50 kHz
Blue	C	1	50 kHz to 5 MHz
Red	E	2	500 kHz to 30 MHz
White	TH	7	2 to 40 MHz
Yellow	SF	6	10 to 90 MHz
Black	W	10	30 to 200 MHz

Color code for powdered iron toroids. Optimum Q usually occurs in the middle of the spectral range.

If you have an exotic junk box and want to try some toroidal inductances in your RF circuitry **Table I** gives a few toroid code symbols that will help you pick the right cores. The powdered metals industry uses two basic means of core mix identification. One uses letters and the other uses numerals. The whole core may be colored to indicate the mix, and thus the frequency range, or the core may be a neutral color with just a small dab of the code splashed on the periphery.

RF toroids are not saturable at practical currents and do not lend themselves to circuit tricks that depend upon making the inductance "lock-up" or "flat-top" due to core saturation. But that's not all bad because a saturated core reduces the inductance considerably and the need for a "swinging" RF inductance is seldom.

. . . W6SFM

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The 220'er

A new horizon for the Twoer

A recent spell of trading left me with a Heath Twoer, which lay on the shelf gathering dust since I already had 100 watts and a Nuvistor converter. A casual remark to K4LHB that "I wish they made a 220'er" brought the reply, "Why not convert the Twoer, since you're not using it anyway?" A look at the schematic, plus Heath's information on possible tuning ranges as given in the manual, showed that operation on 220 was a good probability, so out came the tools and grid-dipper and a few days later I was on 220. Here's how to do it yourself.

A word of caution first. At the frequencies involved here, nothing is cut-and-dried, so a grid-dipper is indispensable, and a wavemeter (most grid-dippers will serve) quite helpful. There can be wide differences in distributed capacitance depending on who built the Twoer you are converting, so grid-dip everything as you go, lest you end up with a 288'er instead. Parts are designated as in the Heath manual, but you can still get by if you don't happen to have one.

Several methods were considered for the transmitter conversion, including use of overtone crystals to permit "straight through" operation of the final, but simplicity won out and the final decision was to *lower* all resonant frequencies to get drive on 110 MHz, and then double in the final. The super-regenerative receiver required no head-scratching, as there is only one logical method—prune the coils to resonate at 220.

The receiver was attacked first, beginning at the detector tuned circuit, L6. Disconnect the end farthest from the chassis and remove not quite 2 turns, which leaves a little over 2 turns of the original 4 turn coil. Set the slug in the coil to resonate at 220 MHz with the tuning capacitor fully meshed, and you will end up with a tuning range of approximately 220-230 MHz. If a smaller range is desired, substitute a smaller value for C27 (fixed capacitor in series with tuning capacitor) and readjust the slug which will have to go farther into L6. A test at this point revealed that the detector would no longer oscillate, so the voltage was raised by substituting a jumper for R12 (68 k) after which everything worked smoothly and the grid-dipper could be heard loud and clear.

The RF stage, L5, was pruned next by taking turns off the obvious end until 3 turns were left. This left C20 (antenna coupling capacitor) much too high for a proper impedance match, so it was moved to a new position one turn from the cold (grounded) end of the coil. From here on, proceed as per the Twoer instruction manual, adjusting L5 for best gain and then L6 to give the correct tuning range again, then back over the same process again and again until no more improvement can be obtained. The tap on L5 can also be adjusted if you want to be particular, but ours came out to just about 70 ohms and was therefore left alone.

One difficulty was encountered in converting the transmitter, and caused a lot of wasted time getting coils to resonate properly. Evidently some of the bypassing is not 100% effective, as coils would dip to the right range in "receive" but not in "transmit". The solution is simple—pull the power plug and leave the switch in "transmit" position when working on the transmitter section.

The first two plate coils, L1 and L2 (associated with pins 9 and 3, respectively of the rear 6BA8) do not need to be pruned, since they must go lower in frequency. Add 15 pF directly across the terminals of L1, which should now hit 18.375 MHz. Add 5 pF from the top (away from chassis) end of L2 to the center of the 6BA8 socket and dip to 55.125 MHz.

The driver stage plate coil (connected to pin 3 of the front 6BA8) also requires lowering in frequency, but I was unable to add capacitance anywhere and still come up with an indication on either of two different grid-dippers. Therefore, the coil was removed and a 2-10 pF piston trimmer capacitor was installed in its place. A coil of 6 turns of #20 wire was wound around a ¼ inch form and spaced to about wire diameter, then installed with the hot end connected to the tab on the piston capacitor and the other end to R5 and

C12 hanging in space. Squeeze (to lower) or spread (to raise) this coil until it will hit 110 MHz with the new capacitor near maximum capacitance.

The final tank coil was a real stinker to get to 220 MHz, due to a lot more stray capacitance than was suspected. The original 4 turn coil was reduced to about ⅝ of a turn before resonance could be obtained with the associated capacitor at minimum. In case you want to be able to restore 2 meter operation in the future, remove the final tank coil and C16 as a unit, take the coil off and save it, and substitute about 1-¾ inches of #14 wire wound to 1 turn like a pigtail. Re-connect capacitor C17 (antenna coupling) about $\frac{5}{16}$ inch from the cold end of the new coil, which should be about right for 75 ohm use. A little closer will match 52 ohms.

With all stages converted and grid-dipped to approximate position, insert a crystal at $\frac{1}{36}$ of the desired operating frequency (6112 kHz for low end of the band, or a surplus 6125 kHz rock will put you on 220.50) and connect an SWR bridge between the antenna terminal and a 75 ohm resistor for a dummy load (or use a #47 bulb as suggested by Heath). Using the bridge, some output was obtained immediately and tune-up was just a matter of going over all adjustments until maximum output was obtained. With a bulb, it may be necessary to fiddle a bit or work in the dark so the first faint glow can be seen. In either case, there is some interaction between the various adjustments, so repeat the process as often as necessary to get to where no further improvement is possible. An on the air check should now be performed, which may require some slight readjustment of the final tuning, and possibly and adjustment of the driver tuning (the new capacitor) which always seems to give best modulation when detuned a bit from maximum output position, even as originally built for 2 meters.

Results have been all that could be expected. The receiver performs the same as on 2 meters, and what little local activity there is (and a lot of spurious junk from TV sets) can be copied on a small yagi. The transmitter puts out approximately the same amount of RF as when it was on 2 meters, due mainly to getting a lot more drive to the final which permits it to double with decent efficiency. Small yagis are available for less than $10.00, and a colinear for $12.95, or either can be built easily from old TV antenna materials. My total cost of getting on 220 was less than $35.00. See you there soon?

. . . K3LNZ

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The Perfect Squelch

Use a dime whistle to activate this simple tone controlled squelch.

Have you ever wished you could monitor your favorite net frequency and hear only pertinent calls without all the associated noise, QRM, idle chatter, etc.

Maybe this gadget is just what you have been looking for. Certainly it furnishes a practical method of monitoring local emergency or traffic nets.

Necessity is the mother of invention, you have often heard. This system was developed to solve a particular problem on the local 2 meter FM RACES Network. When the net consisted of only a few members the normal squelch system made channel monitoring a pleasure when compared to SSB and AM experience.

However as new members were added, the squelch soon remained open for a large part of the day as operators participated in the usual ham chatter.

In searching for a solution to this problem several approaches were considered and discarded before the present system evolved.

It becomes apparent to the discerning technician that various refinements may be added to this system but as presented it has important advantages. The receive portion can be installed in the speaker leads of any receiver with no internal connections. The tone generator is a plastic toy police whistle, available at most any dime store for, believe it or not, a dime.

This type of tone generator has no peer for mobile operation.

Now for discussion of the circuit. The surplus toroids are readily available in either the 80 mH or 88 mH sizes.

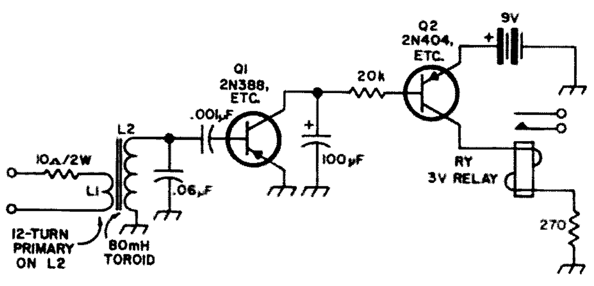


Fig. 1. The perfect squelch, a tone activated squelch that operates on a blast from a plastic whistle.

These toroids allow simple filters that will discriminate against voice frequencies, yet as used here, are not so sharp as to require precise tones to actuate.

Q1 should be a silicon transistor to prevent leakage problems; however, if you insist on a germanium type, use a silicon diode in the emitter lead and it should work fine.

Upon receiving a tone of the proper frequency, Q1 conducts and discharges C3. When the tone is discontinued, C3 recharges through R2 and the base emitter junction of Q2 keeping the relay closed during the recharge periods.

Installation of the circuit is accomplished by connecting the 12 turn link, through the 10 ohm resistor, to the 4 ohm output terminals of the receiver.

One of the speaker leads is now connected to the high side of the 4 ohm receiver output and the other speaker lead is returned to ground through the relay contacts.

The relay used here is the 3 volt relay used in the weather bureau radiosonde. These relays are available surplus at surplus prices.

However, any relay may be used that meets the requirements imposed by the supply voltage and Q2 current capacity.

On the air use of this system is as follows. Blow the whistle for 3 to 5 seconds then proceed to call your station in the normal manner. The whistle should have closed his relay and connected his speaker for approximately 10 seconds, allowing time for the call.

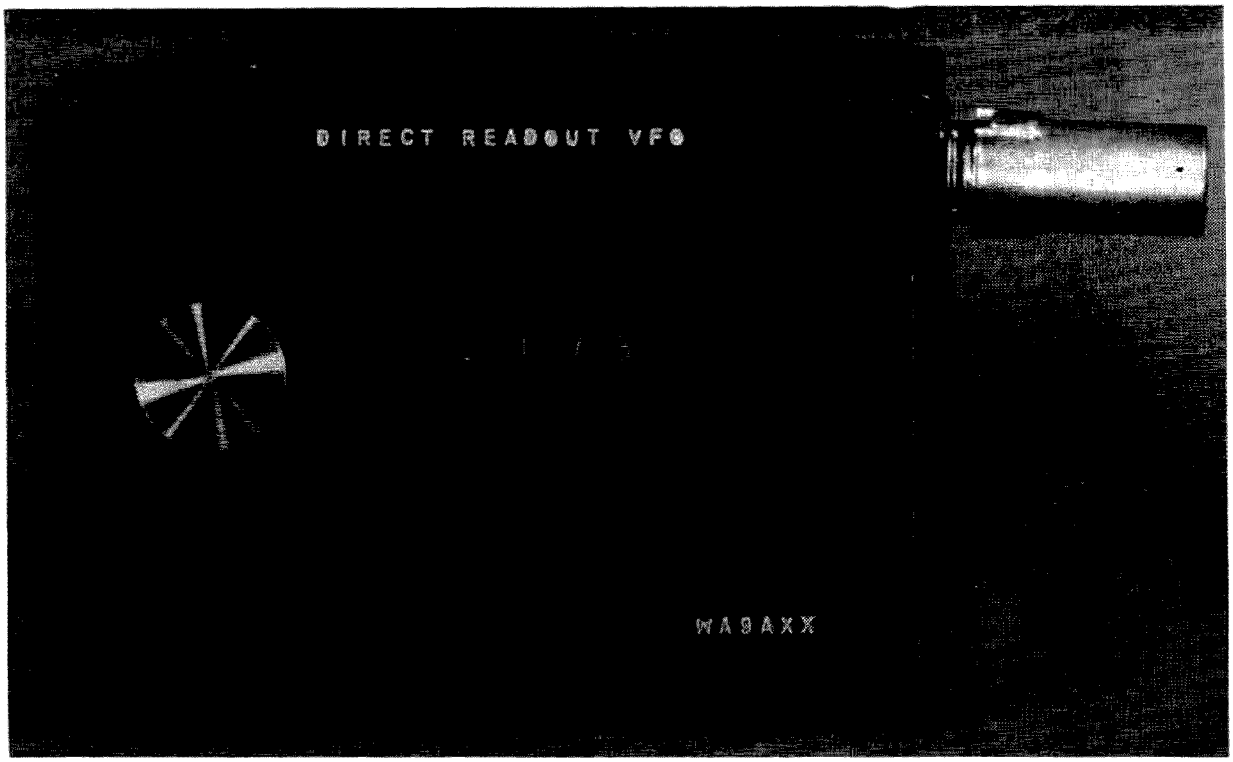
This time constant may be made longer by enlarging C3 or R2.

The maximum resistance used for R2 will be determined by the gain of Q2 and the required relay current.

After reading the FCC regulations it is my opinion that these signaling tones are legal on the ham bands, but maybe you should read them; you probably need to review them anyway.

The author wishes to take this opportunity to extend credit and appreciation to the members of the Houston, Texas RACES for their assistance and indulgence while this system was being developed.

. . . W5VCE



External view of WA9AXX's digital readout VFO.

Borje Ost WA9AXX
1526 Potter Road
Park Ridge, Ill. 60068

Digital Readout VFO

It is desirable in tuned rf oscillators to have a uniform tuning rate and linear frequency scale. Such a VFO permits digital readout, with advantages of clear display in a small indicating device. It can be safely assumed that we will see more of the dials with the flipping numbers in the future. The construction of a linear VFO is neither complicated nor need it be costly. The VFO shown in the photos was built a couple of years ago, using surplus parts and housed in a sturdy aluminum box. The linearity (without bending any capacitor plates) is within 2 kHz over the range 5-5.5 MHz, the standard VFO range for many 9 MHz *if* rigs. The readout is accurate to 200 Hz. There is no evidence of backlash. It was originally designed for use in a homebrew receiver similar to the SB-300, but since I acquired a Galaxy V transceiver, I am now planning to use it as a remote VFO to give a choice of two transmit and receive frequencies. The cost of the unit ran less than $10.

The heart of any VFO is the tuning capacitor or the coil, whichever is made tuneable. It is far simpler to make a capacity tuned oscillator than an inductance tuned one, especially if a linear frequency scale is attempted. A permeability tuned oscillator (PTO) coil, used to give linear frequency coverage, is specially wound with varying winding pitch. On the other hand there are capacitors generally available with rotation-capacitance characteristics that can provide linear tuning over a specified frequency range. The common formula for capacitance as a

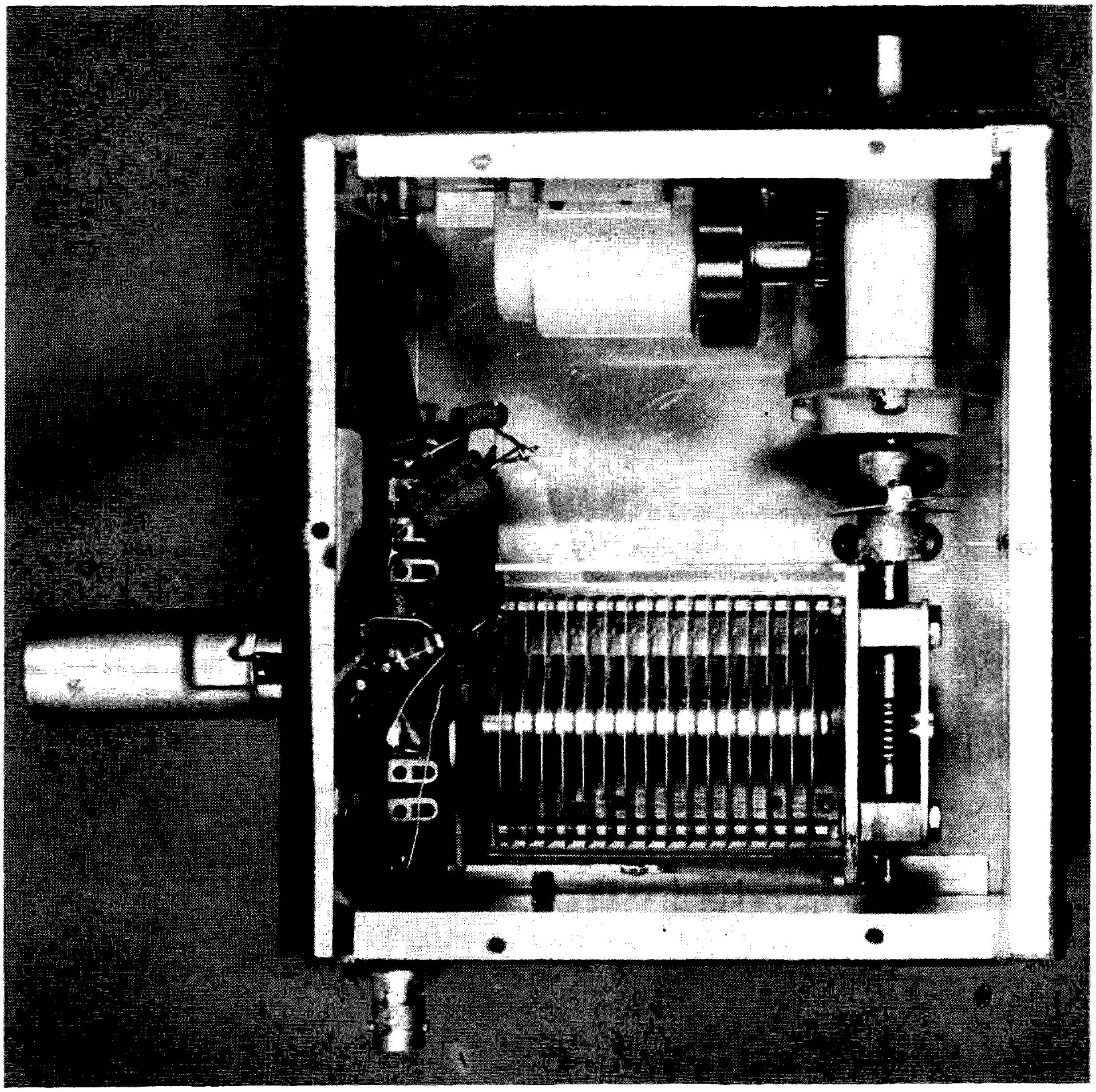
Borje is a research chemist for the Portland Cement Association (B Ph, Northwestern). He likes DX'ing and RTTY.

function of frequency and inductance:

$$C = \frac{1}{4\pi^2 f^2 L} \text{ (L being constant)}$$

shows the inverse square relationship that has to be satisfied by special shaping of the capacitor plates. Capacitors of this type are known as straight line capacitors and are available at nominal cost. The capacitor I chose was part of the ARC-5 transmitter. If you do not have an old ARC-5 that you can cannibalize for the capacitor, you can get it from one of the surplus houses for about one dollar or less. The capacitor is solidly built and already has slow tuning built in. It takes almost 50 turns of the shaft to close the capacitor.

The capacitance of the unit was measured at several settings of the shaft and was found to be as required excepting end effects when the capacitor was just opening or closing. The secret for getting a truly linear VFO is obviously not to use the extreme ends of travel of the plates. The capacitor has a nominal capacitance of 25-150 pF. To avoid any of the end effects I used only the 40-124 pF range. The circuit shown in **Fig. 1** will tune to 5 MHz with the capacitor set at 124 pF, to 5.25 MHz at 77 pF, and to 5.5 MHz at 40 pF. These values are close to optimum, but small adjustments can be made in either the tuning of the capacitor or the coil when the circuit is operational.



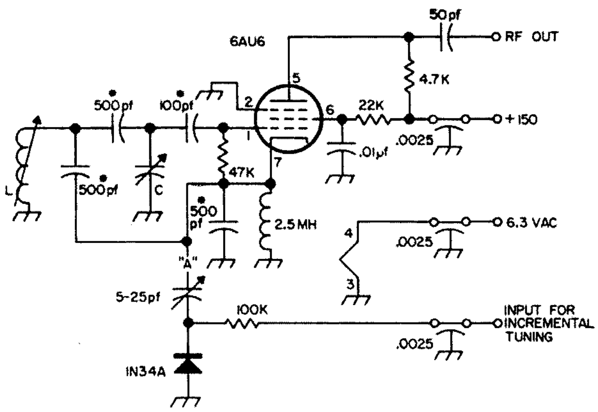
Inside of the digital readout variable frequency oscillator.

To transfer the movement of the shaft into correct readings on a counter, all that is needed is a gear with the correct number of teeth to couple the shaft to a counter. My counter (modified part from old BC-653) reads 0-500 kHz and has a large vernier wheel for visual readout to 200 Hz. The readout mechanism I used is bulkier than necessary. Suitable counters are available at low prices. Choose one with large numbers.

The linearity and frequency stability of the unit are excellent; warmup drift is of the order of a few hundred cycles, long time drift is much less. No detectable frequency modulation is caused by pounding or dropping the unit. Special attention should be given to the construction of the coil. A stable coil could be obtained by using phosphor-bronze dial cord wire wound on a ceramic coil form under slight tension. Solid construction results in stability. The heavy aluminum case, and small power dissipation inside it provide low thermal drift.

Other straight line capacitors can be used to provide linear coverage. Many of these are able to handle up to 2:1 frequency ratios and can be used in parallel-series circuits to cover the small frequency ranges usually needed in amateur gear. I have tried the ARC-5 capacitor over other frequency ranges with equal success. The choice of parameters for the linear circuits is based on an unpublished method developed by W9TO, of keyer fame. It is hoped that Jim will find time to prepare an article on the subject in the near future.

. . . WA9AXX



NOTES
C = 25-150pf FROM ARC-5 (40-124pf RANGE USED
L = 2.84µh SINGLE LAYER ON CERAMIC FORM (PREFERABLY PHOSPHOR-BRONZE WIRE)
• = SILVER, ZERO TEMPERATURE COEFFICIENT
"A" = BREAK HERE IF INCREMENTAL OR CALIBRATION TUNING IS NOT DESIRED

Fig. 1. Digital readout VFO for 5.0-5.5 MHz.

Six V Oscillator

Here is a simple audio generator that will find many uses around the shack. A glance at the circuit will show that there is no high B+. This generator has a plate supply of only 5 volts and the plate current of around 100 µA equals or betters many transistor circuits. The plate voltage is taken off the same 6 volts used for the tube's filament.

The unit was designed so that it can be run on both 6 or 12 volts and either AC or DC so it can be used in the shack or the mobile. If you plan to use it just in the shack a small 6 volt filament transformer can be mounted inside the case and J2 can be eliminated.

Power is fed in thru J2 using different cables for 6 or 12 volts. While the same cables are used on either AC or DC the cable is color coded so that when using on DC the proper polarity is maintained.

The tone output of this unit can be varied from around 20 Hz to around 12,000 Hz. The upper limit can be raised up to around 15,000 Hz by changing C1 to about .01 µF.

The unit can be put into any small aluminum box or chassis since parts placement is not critical. While the schematic shows a pot for R3, a switch and fixed resistors can be used to give specific tones.

The generator is meant to be used with a high impedance load but a matching transformer can be added if you need low impedance output.

Use an ordinary shielded cable terminated with phono plugs for audio work.

To increase audio output a pot can be used in place of R5 to set the required value for your requirements.

While the output tone is not a true sine wave, I'm sure this generator will find many uses in the shack or test bench.

. . . Don Marquardt K9SOA

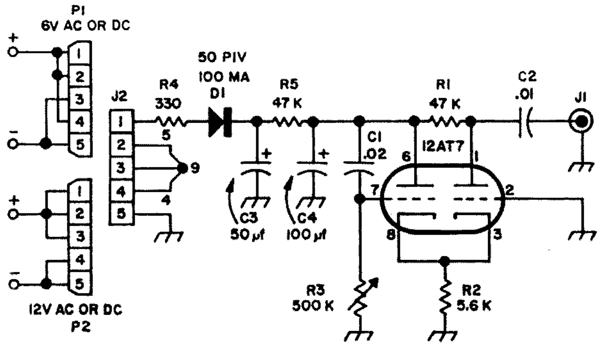
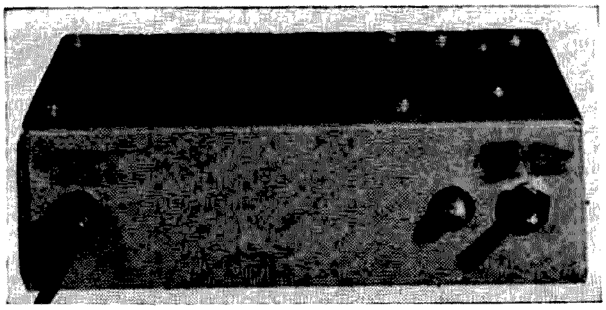


Fig. 1. Simple audio oscillator operating on 6 or 12 V.



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Palo Alto, California

A 50 kHz Marker Generator

Most secondary frequency standards for amateur use fall into one of three categories: those producing 10 kHz-spaced marks, those producing 100 kHz-spaced marks, and those producing 3.5 MHz and harmonics. The first type is represented by an article by Campbell, wherein a 100 kHz crystal oscillator is used to injection-lock a 10 kHz free-running multivibrator.[1] The second type is that found in most commercial H.F. receivers as the (often optional) 100 kHz calibrator—the Collins 75A2, is an example. The third type, strictly for amateur H. F. receivers, produces 3.5 MHz, 7.0 MHz, 14.0 MHz, 21.0 MHz and 28 MHz marks which identify only the *lower* edges of these five popular bands.[2]

If you are the proud possessor of one of the newer "ham-band only" receivers which have inherent good calibration, then the only type of calibrator which would interest you is the 100 kHz variety and it is probably already "built-in" or available as a plug-in unit on your receiver. If, however, you are using a BC312, BC348, a home brewed unit, or a general coverage type receiver (with separate band-spread dial), this 50 kHz calibrator will probably interest you. On the author's BC312, a 10 kHz interval generator is not too useful because on this receiver there is no band-spread tuning control and the 10 kHz marks come too close together. However, with a 50 kHz interval generator, it is much easier to tell *which* mark is really *where* on the dial.

For instance, the 3700-3750, 7150-7200, and 21,100-21,250 kHz novice-bands are well marked at their edges by a 50 kHz calibrator. Also, 14,350 kHz is marked for those with general or advanced-class licenses. The HF amateur bands, then, are completely edge-marked by a 50 kHz interval generator without using an excessively-dense family of 10 kHz intervals. If you are contemplating 160 meter operation or if you are a "VE", either of whom needs 25 kHz marks, an additional flip-flop, added to the circuit, will provide that function with no adjustment, and only 16 additional parts.

The circuit is similar to one by Grigg, in that non-critical digital circuits are used for pulse generation and frequency division.[3] The basic 100 kHz crystal oscillator utilizes an inexpensive field-effect transistor to make it possible to use the ordinary 100 kHz crystals that are available for tube circuits. One *could* buy a 100 kHz crystal (to order) from International Crystals for $15.00 and specify that it be cut to operate in the series-mode for a common-transistor circuit. Here, however, it was decided to use a $4.95 crystal from Texas Crystals, which appears to be cut for the CR37/U specifications (20 pF, parallel resonance at 100 kHz). The problems associated with crystals and crystal oscillators is more fully discussed in a previous article.[4] In short, the use of a field-effect transistor makes possible the choice of an inexpensive crystal.

The oscillator is followed by an isolation amplifier and then a Schmitt Trigger. The Schmitt Trigger drives a flip-flop (or more technically: an Eccles-Jordan bi-stable multivibrator). The output of the flip-flop is exactly one half the oscillator and Schmitt trigger frequency, and is an extremely fast rise time square wave. As a matter of fact, the output of the Schmitt trigger is also a fast rise time square wave, and *can* be used alone to generate 100 kHz harmonics. Either the trigger output or the flip-flop output square wave (there's an output jack for each) can be coupled lightly to the receiver antenna for calibrating marks. Note that it is the fast rise time of the square wave that controls the degree to which

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Hank is one of the best qualified ham authors around. He's written many excellent articles for 73 (and other magazines), all on new devices and concepts. He has an MS in EE from Stanford and is an engineer at the Stanford Research Institute.

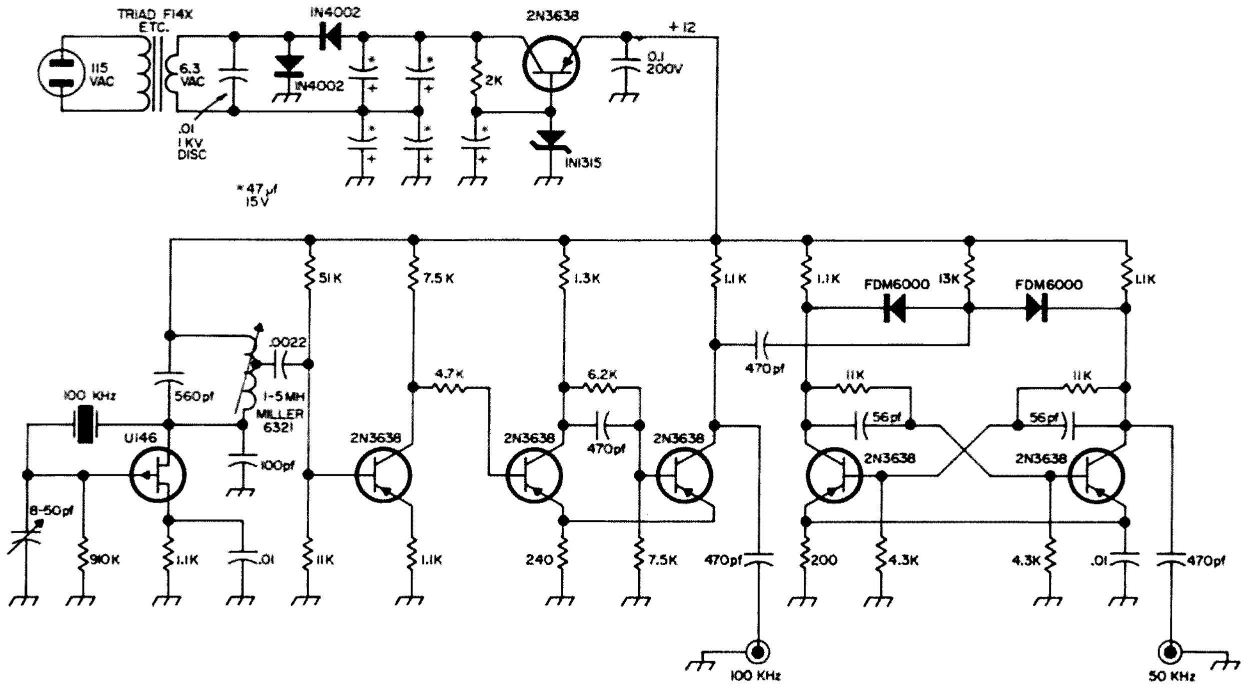
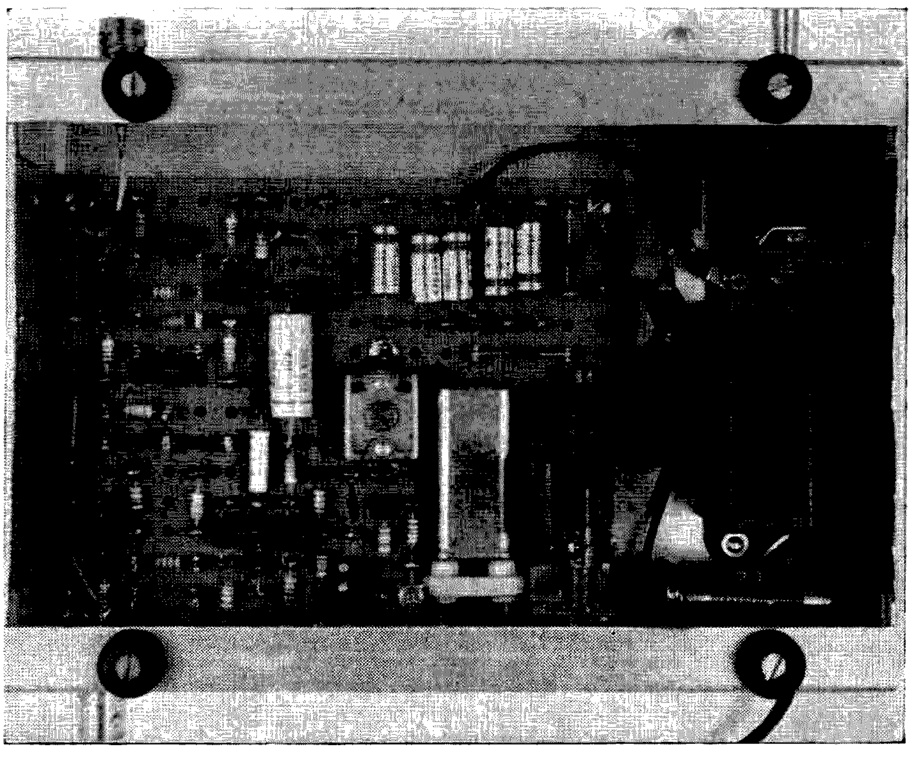


Fig. 1. Schematic of W6GXN's 50 kHz marker generator. A field effect transistor is used as the 100 kHz crystal oscillator to permit the use of a low cost crystal designed for tube circuitry.

harmonics are generated. This circuit has a rise time of about 0.1 microsecond at both the trigger output and at the flip-flop output. The harmonics generated are heard easily through the six-meter band, which should be high enough to satisfy most needs.

Note in the circuit the use of 2N3638 type silicon transistors, throughout, except for the crystal oscillator. These inexpensive little gems are advertised as "2N404 replacements" (at only $0.41 each) but are really *much* better! The 2N3638 is a silicon, PNP, switch; that is faster than a 2N404 (germanium, PNP, switch) by an order of magnitude, and hence generates harmonics more efficiently. To simplify procurement, another 2N3638 is used in



Inside of the 50 kHz calibrator. Most of the circuit is constructed on Vector perforated board.

the series regulator circuit in the power supply. It is recommended that the experimenter *not* try to substitute other transistors for the 2N3638's, especially in the flip-flop section. The author, too, had a handful of surplus 2N269's and 2N404's, but preferred to use $2.46 worth of 2N3638's for better performance.

The steering diodes in the original version, in the flip-flop, were Fairchild FD135's. However, nearly any silicon computer diode will do, including: 1N658, 1N3604, 1N4009, 1N4154, or the new inexpensive Fairchild epoxy FDM6000's.

Construction is on Vector multihole phenolic board 64A18 using Alden 651T terminals. The board layout is shown in the photo and the circuit in **Fig. 1.** The board is mounted, using four ¼" spacers, inside the 5 x 7 x 2 chassis that serves as a cabinet. The power transformer, switch, fuse holder, pilot, and jacks are not on the board but mounted on the cabinet. The finished unit as it is used is shown sitting on the author's BC312 coupled to the antenna terminal via a short length of RG58/U and a 5 pF silver-mica capacitor.

. . . W6GXN

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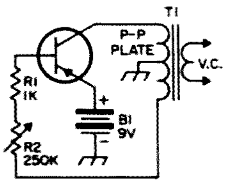
1. Campbell, "A Junk Box Frequency Standard," QST, Jan. '64, p. 22.
2. Crosby, "The HBR16," QST, October '59 P. 11
3. Grigg, J., "A Transistor Secondary Frequency Standard," QST, July '65, p. 11.
4. Olson, H., "Crystal Oscillators, Tube, Transistor, and FET" 73, March 1966, p. 14.

Simple CPO-Transistor Checker

This simple code practice oscillator also is handy for checking transistors and supplying an audio tone for testing equipment. R_2 adjusts the frequency of oscillation, which will also be affected by the transformer used for T_1. You can get high impedance output



through a .01 μF capacitor connected to the collector of the transistor. The battery polarity shown is correct for PNP transistors. Reverse it for NPN types. Most power transistors will work in this circuit. Generally speaking, transistors that oscillate in this circuit are usable.

. . . Ron Baker W8JIA

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Designing a Junk Box Preamp

Build this simple preamplifier to soup up your inexpensive receiver. It's perfect for novices.

When I began as a novice about a year ago, I realized that my Knight-Kit R-55A receiver could definitely use a bit of help in the front end. I scrounged around for a suitable circuit of a preamp. After flipping through various magazines and handbooks, I found that they all called for parts which I didn't have. So I decided to design one of my own using the parts in my junk box.

Since then, I have been asked a number of times for a good rf amplifier circuit which would be easy to put together. It seems that many novices tend to purchase budget receivers, like I did, to start off with. Once they become generals, or maybe before then, they invest in a better receiver. In the meantime, that little budget receiver causes big headaches with low sensitivity, poor image rejection, instability, and lack of selectivity. My purpose in writing this article is to end all of this searching for circuits, and to help beginners, and maybe some not so new to radio, design and build a good preamp using whatever parts they might have on hand. This will take care of the first two problems mentioned above with a minimum of expense and trouble. The other two are much harder to tackle and can run into considerable money.

It's all really very simple. First step is to find out what tubes you have on hand and if any of them can be used in the circuit. Actually, almost any rf or *if* pentode can be used. The accompanying table lists the more popular types. Notice that only pentodes and not triodes are specified. Triodes can be used and, although they have a better noise figure, it is not needed on the hf bands. They also have a lower plate resistance which loads the receiver's input circuit and reduces the selectivity and image rejection. Neutralization is also required with triodes. There is no sense in going through all that bother when there is absolutely no need for it. The pentode section of dual purpose tubes may also be used. Since there are so many of these types of tubes (such as 6U8, 6CX8, etc.), a table containing them all would take up too much room. A tube manual will be necessary if you are planning to use one of these. Some tubes are better than others and are to be preferred such as the 6AH6, 6BZ6, 6DC6, 6AK5, and 6BJ6. However, others will do almost as well.

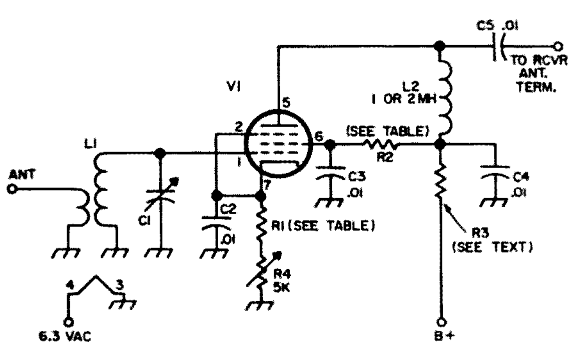

Fig. 1. Schematic of the junk box preamplifier.

Next step is to determine the supply voltage. Most receivers and transmitters can spare enough power for the tube, and those that can usually have an accessory plug in the rear. One important word of caution is in order here. Check the voltage of the transmitter's supply if you intend to use it. Don't rely on the instruction manual. The manual to my rig states that the voltage at the accessory plug is 410 volts. Taking this for granted, I hooked up the preamp and within a few days the tube went bad. Being slightly suspicious, I checked the voltage of the supply with a voltmeter and found it to be 560 volts! It seems that, when receiving, the voltage would rise and only when the rig's key is depressed does it drop to 410 volts. So be careful! In any event, if you feel that neither one can stand the added load, it would be wise to build a separate supply. Any supply delivering 300 volts at 20 mA will be entirely adequate. If your supply voltage is greater than the listed plate voltage of the tube to be used, a voltage drop-

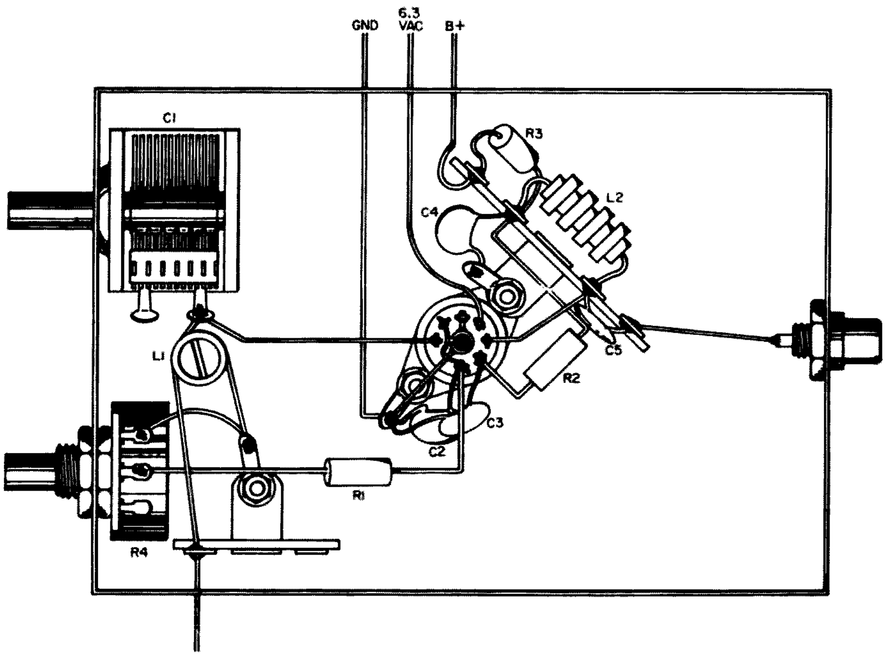

Fig. 2. Layout of the junk box preamplifier for the high frequency ham bands. The value of L1 is discussed in the text. Almost any coil that will tune to the desired frequency with C1 is suitable.

ping resistor will be necessary. Let's take an example. Suppose we select a 6AU6 and our supply voltage is 400 volts. The plate voltage of the 6AU6 is listed as 250 volts. The necessary drop is the difference in these two voltages.

$$400 - 250 = 150 \text{ V}$$

Our dropping resistor has to develop 150 volts across it. The plate current for the tube is 10 mA. Using Ohm's Law we get for R_3

$$\frac{150}{.01} = 15{,}000 \text{ ohms}$$

The wattage is

$$150 \times .01 = 1.5 \text{ watts.}$$

A three watt resistor should be used. If the supply voltage is approximately the same as the tube's plate voltage, you need not worry about the dropping resistor.

The cathode and screen resistors can be taken directly from the table. The 5 k gain control can be left out if desired. It is used only on very strong signals and is left fully on most of the time. This control will not cut off signals completely, only reduce them. The bypass capacitor values can vary slightly from those given.

The input circuit is not critical at all. For C_1 I would recommend a broadcast replacement type, 365 pF. This large value gives a greater operating range, although tuning may be a little critical due to the sharp selectivity. You may wish to parallel it with a smaller capacitor of about 25 to 50 pF as a vernier adjustment. The coil L_1 can be just about any type of the proper value. I have used both air wound and slug tuned coils with success. A 1 to 2 μH coil should give an operating range of approximately 6 to 35 MHz. However, it may be that, after the unit has been completed, it does not cover the desired bands. In this case, a homebrew or commercial air wound coil would be ideal because the number of turns can be adjusted easily. Extra capacitance can be added across C_1, but the "Q" of the circuit might be lowered too much. Anyway, a little juggling of coils and capaci-

Preamp Design Chart

Tube 1	Plate Voltage	Screen Voltage	Plate Current (ma)	Cathode Resistor R_1 (ohms)	Screen Resistor R_2
6AK5	180	120	7.7	220	27 k
6AU6	250	150	10.6	68	33 k
6AH6	300	150	10	160	62 k
6AG5	250	150	7.5	180	47 k
6BA6	250	100	11	68	33 k
6BH6	250	150	7.4	100	33 k
6BJ6	250	100	9.2	82	47 k
6BZ6	200	150	14	56	22 k
6CB6	200	150	13	56	12 k
6DC6	200	135	9	180	24 k
6BC5	250	150	7.5	180	47 k
6BD6	250	100	9	180	47 k
6DE6	200	125	15.5	56	18 k

tors will bring about the desired results. The coupling link in the antenna circuit can be a couple of turns of hookup wire wound adjacent to or around L_1. You can also connect the antenna to a tap on L_1. It should be closer to the ground end and is usually adjusted for a fifty ohm load. About two turns for the link, and about one-fourth of the way up for the tap are good starting points.

The output choke's value is not critical, but if anything lower than 1mh is used, there might be a noticeable loss at the lower frequencies. The output should be coupled to the receiver preferably through a coaxial cable.

When building, keep all leads short, especially those of the bypass capacitors. Input leads should be kept as far away from the output as possible. This point cannot be overemphasized. It is much easier doing it right the first time than having to go back and starting all over. If no precautions are taken, the tube will most likely begin oscillating. If this happens to you, check for poor layout first, then for bad solder connections. One of the bypass capacitors might be defective. If you happen to have another tube of the same type, substitute it. This will sometimes cure low sensitivity, too. Never rely on a junk box tube too heavily, unless you are absolutely sure it is in good shape. It should be one of the first things to suspect in case of trouble.

As stated before, there are many different tubes which can be used in this circuit. If you want to use a particular tube not listed here, just look it up in a tube manual. In most cases the cathode bias resistor will be given. The screen resistor is calculated in the same manner as before. Find the difference in the plate and screen voltages and divide that value by the screen current in amps. Again, don't forget the wattage rating of the resistor, voltage times current (in amps).

Let me reiterate here that the grid tuning circuits are quite flexible, so don't be afraid to try out various kinds. Almost any coil-capacitor combination can be used, although a slight adjustment will be necessary to bring it on the desired band. Make sure you don't exceed the listed plate and screen voltages in the table. In most cases these are not maximum ratings but there is no sense in pushing them all the way. The increase in sensitivity will be negligible and in some cases will even be less because of the extra noise introduced into the circuit. Tube life might be cut down too.

If the tube in the preamp should ever happen to fail and you don't have a replacement on hand, it won't be necessary to rush down to the nearest electronics distributor. All you have to do is change a couple of resistors, and any other tube can be substituted. Some tubes have 12 volt counterparts which can be used in case a 6 volt supply is not handy. The unit can be built in a minibox, utility cabinet or even incorporated into the receiver. In any event, you will find it very helpful in pulling the weak ones from under that ever present noise, and in eliminating the annoying image on the other side of your oscillator frequency.

. . . WA4ZQO

Tap to Talk Relay

This circuit allows a transmitter to be controlled with only a momentary action of the push-to-talk switch, which should be especially convenient for mobile operation. It can be used with any leaf type push switch that does not have snap action.

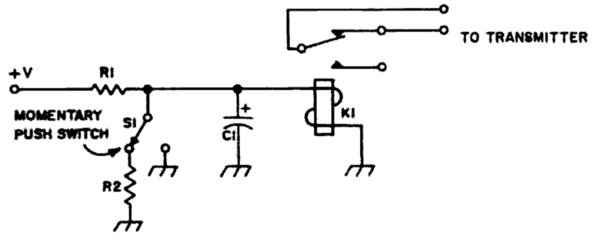

Fig. 1. Tap to talk relay. See the text for choice of components.

In Fig. 1, K_1 is a sensitive relay, such as the Sigma type 11. Select a relay that will operate on one-half the available supply voltage, or less. With R_2 disconnected adjust R_1 to just barely pull K_1 in. Select R_2 to cause K_1 to hold in once it is manually closed but to allow K_1 to remain open when manually opened. C_1 is a small electrolytic selected so that when S_1 is depressed then quickly released, K_1 stays closed.

K_1 is now normally closed in the receive position. To transmit, push and quickly release S_1. To receive only partly depress S_1 (if fully depressed by mistake, then release slowly). To transmit briefly (break) push S_1 and talk, then release slowly.

. . . Tom Lamb K8ERV

HOW WELL DO YOU KNOW YOUR GEAR?

Hams are supposed to be knowledgeable people—at least concerning radio. It always puzzles me then, particularly as a dealer in ham equipment, to find so many examples of people—hams, that is—who otherwise fail to understand the significance of what they have read. Now, I am not trying to carp or to ridicule anyone. That would be an inconsistent gesture from someone who is trying to make a living in ham radio. What I am trying to do is to make more of you aware of the need to understand what takes place in any particular piece of gear—not merely how to turn the knobs or to talk into the mike. If you want the solid satisfaction of getting the most out of your gear, then you ought to read the instruction book as often as it is necessary to understand what takes place between the oscillator and the antenna. Transmitters, and for that matter receivers, represent compromises between the ideal and that which is practical. They represent an effort by a manufacturer to produce a product that will fulfill most of your requirements and to do so at a profit for him and those who handle the gear. No commercial piece of equipment is free of bugs or shortcomings in design of one type or another—no, not even Collins is perfect. When you see the magazine writeups on new products, you hardly ever find the author describing what is wrong with a piece of gear or what its weakness is or where it could be strengthened. To do so would probably result in cancellation of the advertisements from that magazine by the manufacturer involved. It is up to you as an individual owner to learn the advantages or the disadvantages of your own set.

One specific case comes to mind and I have never seen this glossed over anywhere. I am referring now to the effect of unreasonable VSWR ratings on the transmitter that you own. Most manufacturers specify that their product is intended to operate into a load with a VSWR not greater than 2.5 to 1. If you were to buy such a product and then to operate it into a dipole coaxially fed on 80 meters and to slide up or down from 3800 to 3999 kHz, you would *have* to *have* a standing wave ratio greater than that provided for by the manufacturer in his original design. *Most hams don't realize this.* They have been told that VSWR isn't too important—that it only affects the efficiency of the radiated signal. Baaaa . . . I wish I had these individuals in our service department sometimes and could show them what happens in the tank circuit of an otherwise beautiful transmitter when they operate in this manner. You are likely to exceed the dissipation rating of the tubes; you are likely to melt or otherwise severly damage the pi coil; you are likely to burn the insulation out of the loading capacitor; and all of this simply because you do not have an understanding of what the injurious effect of high VSWR is. Remember to always operate your transmitter within that portion of the band pass of your antenna system which provides you with a VSWR of less than 2.5 to 1. A good rule of thumb is to monitor your forward and reflected power. When the reflected power equals 10% of the forward power . . . WHOA! . . . back off and tune back in frequency.

This is just one part of your transmitter and the transmitter is just one part of the station. If you want to do the best thing possible to aid your station, concentrate your efforts on your antenna and its installation; nothing else in your station will result in so marked an improvement. If you are still persistent, get the best receiver which you are capable of *understanding* and operating and if you still insist on a new transmitter, by all means buy it, but this is the one area where you will likely have the least amount of practical gain.

We are in the business of helping hams to help themselves. If you have a question concerning an element of your station, I wish you would write us. If you need an instruction book or schematic, maybe we can help and we'll do it at a nominal cost. But, if after all is said and done you still want to improve your station, my suggestion is to get the original manufacturer's instruction book out, go over it once again until the schematic is thoroughly understood. This will probably pay you off better than that TV western you were watching anyway.

73

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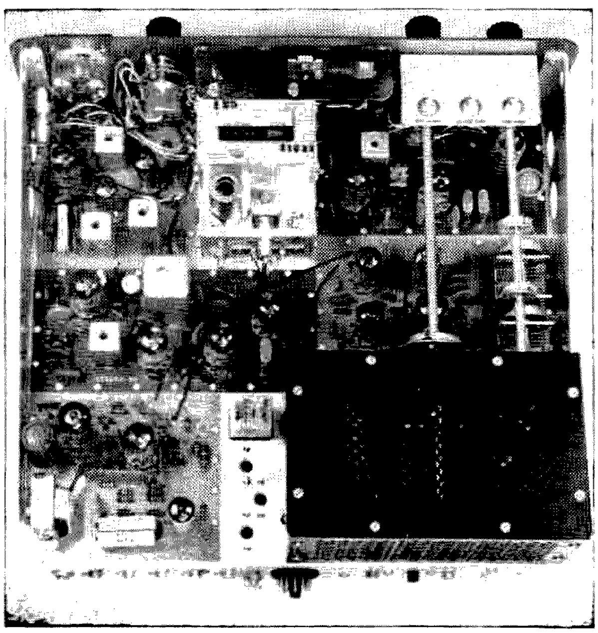
Heathkit SB-100

Heathkit, realizing the need of the Amateur Fraternity for a quality, low cost line of SSB equipment, has marketed their "SB" line. One of the newest of the SB-Series is the SB-100 all-band transceiver, which operates on all amateur frequencies between 3.5 MHz and 30 MHz. It may be used either as a fixed-station or in a car, boat or airplane as a mobile-station, with either the AC or DC external power supply, using either A-3j (SSB) or A-1 (CW) emission.

Although Heath claims that the SB-100 kit can be built in about 45 hours time, a ham inexperienced in building equipment may expect to add about 5 hours to the building time. As an experiment, my wife, who has never built any electronic gear, wired two of the larger circuit boards perfectly, following Heath's step-by-step directions.



A Waters wattmeter/dummy lead showed an output of approx. 110-watts at 7.2 MHz with a DC input of 170 watts. The CW input to the final amplifier may be "cranked-down" so that a novice can use it in accordance with the regulations regarding his license. But, you say, he must be crystal-controlled as well. Fine. Just figure (with a formula in the manual) the crystal that is required to control the transmitter section. The LMO Switch, or, as it is labeled "OSC. MODE," has three positions: LMO, in which the transmitter and receiver are both controlled by the Linear Master Oscillator; an XTAL position, where both the transmitter and receiver are controlled by the afore mentioned crystal; and AUX. T where the transmitter is controlled by the crystal and the receiver is controlled by the Linear Master Oscillator. Perfect for net control stations or novices, eh?

When operating CW a sidetone of approximately 1000 Hz is internally switched to either the speaker or headphones for monitoring your fist. Another interesting feature is that when the earphones are plugged in, the jack automatically switches the audio output from 8 ohms to 600 ohms, more closely matching the impedance of the headsets used in most ham stations.

There are no controls on the rear apron, only connectors. Some of the least used controls are mounted internally such as: VOX adjustments, headphone volume, bias, CW tone level, carrier null, neutralizing, meter zero and relative power adjustment.

On the air, I have received excellent audio reports. One of the local hams, who has a 'scope tied to his receiver said that the pattern appeared to be of the same high quality

as from the "high-priced equipment." The 'scope connected to the SB-100 produced an excellent "Christmas tree" pattern.

The dial tunes 500 kHz, so that means there is no bandswitching on 80, 40, 20, or 15 meters. The 10 meter band is divided into four sections; 28.0 to 28.5, 28.5 to 29.0, 29.0 to 29.5 and 29.5 to 30.0. There is also an additional 10 kHz at the top and bottom of the dial. Time and frequency checks can be taken from CHU at 7.335 MHz.

In the transmitter section of the SB-100, the audio from the speech amplifier and cathode follower, as well as RF from the carrier oscillator is fed into the ring-type balanced modulator. From there, the signal is impedance-matched to the 3.395 MHz crystal filter. The filter has a usable bandwidth of 2.1 kHz (3393.95 to 3396.05 kHz at the 6 dB points). The audio frequency range is held between 350 and 2450 Hz. An optional 400 Hz CW filter may be used instead of the SSB filter, but then operation is limited to CW only.

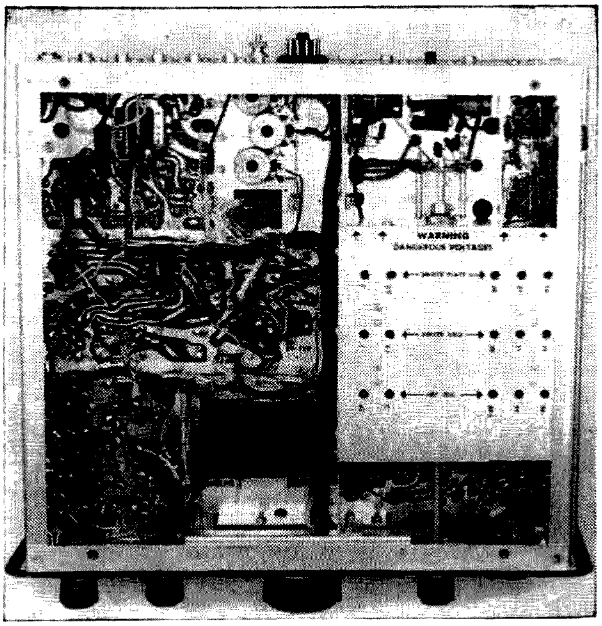
The LMO signal (between 5.0 and 5.5 MHz) is mixed with the SSB signal at the first transmitter mixer. The sum of the two signals is then fed through a bandpass filter to the second transmitter mixer, where it is then mixed with a signal from the heterodyne oscillator. The difference between these two signals produce the operating frequency.

The rest of the transmitter section is of conventional design. Two 6146's are used for the class AB1 linear amplifier. These tubes were designed for transmitter circuitry, and I'm glad to see Heath using this popular tube.

The receiver section is of conventional design, using the 2.1 kHz crystal filter to set the bandwidth. This narrow, steep-sided passband permits good selectivity in the crowded amateur bands. The audio transformer secondary is tapped to match either 600 ohms or 8 ohms.

There are five main circuit boards that are attached to the chassis, and four small boards which make up the band switch. The LMO is factory-wired and completely aligned.

The first assembly is that of the circuit boards, being careful to solder the components in their proper places. After installing some of the hardware on the chassis, the circuit boards are mated to the chassis. Two wire harnesses (one of color-coded coaxial cables) interconnect the boards, terminal points and controls. Then the chassis wiring is completed, followed by the assembly and installation of the front panel. One of the last steps in the assembly of the SB-100 is that of the Switch-Board™, which comprises of four small cir-



cuit boards, each with a switch wafer and associated components, that is used for the bandswitch.

To align the transceiver, only very basic equipment may be used, such as an 11 megohm VTVM, a 50 ohm non-reactive dummy load and a receiver that tunes the standard broadcast band. An oscilloscope is recommended, but not necessary for transmitter alignment.

In mobile operation, there is not even a hint of frequency variation, even over rough roads. The circular dial has 1 kHz divisions, and the visual interpolation is approximately 200 Hz or less. I have found that linearity of the LMO is within 150 Hz after calibration at the nearest 100 kHz point. Backlash is negligible on my unit.

All "on-the-air" reports have been excellent, either barefoot or using a linear amplifier. The CW break-in keying produced an excellent wave shape on the oscilloscope used for monitoring. A sidetone provides CW monitoring either through the speaker or headphones.

Either an AC power supply (HP-23) at $39.95, or a DC power supply (HP-13) at $59.95 is available to supply the operating voltages required. The unit, weighing only 17½ pounds, is 14⅞" wide x 6⅝" high x 13⅜" deep. A separate speaker is required, such as the SB-600, which also provides space for the AC supply.

I have worked at least 30 other SB-100's in the few months that they have been on the ket, and I have yet to hear one with poor quality. Heath Company has a winning line in the "SB-Series."

. . . K2EQB

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High Frequency Power for Standard Equipment

Don't throw away that 400 Hz generator. It's fine for Field Day.

"That high-frequency generator sure is nice and compact, and cheap, too. Pity we can't use it for Field Day. All the power transformers would burn up."

This is one of those things that "everybody knows is true," but it is more or less an old wives' tale. Actually, ordinary small transformers will run a little cooler when operated from a power source of higher than rated frequency. Low frequency is what burns up iron; if you try to feed 25 hertz power at full voltage to a 60 hertz transformer, you get a cloud of smoke and a bad smell. If you connect a 400 Hz transformer to the 60 Hz line, the same thing happens, only faster. But a 60 Hz transformer on 400 Hz power? Ok, fine business.

But doesn't the iron loss increase with frequency, and don't 400 Hz transformers use special iron? Sure they do. Where's the catch? Simply that, in a given transformer, the flux density, or magnetic intensity, in the iron goes down as the frequency is raised. If it were not for losses going up, you would expect a transformer designed for 60 Hz to have six times as much core as needed when operating at 400 Hz. Because of losses, it actually has about twice as much as needed. The special iron enables a smaller transformer to be designed at any frequency, but the benefit is greater at high frequencies and makes the extra cost of the iron worth while at 400 Hz and up. Ordinary iron works at high frequencies perfectly well if not pushed too hard, as we shall see.

Jim was first licensed as W9LZV in 1938. He's a research associate for Stanford University (BSEE, IIT 1957).

Transformer losses

The losses in a transformer are what cause it to heat up. They are of two kinds, core loss and copper loss. The copper loss depends on the current drawn from the transformer; it has nothing to do with frequency (at least in the power frequency range) so we can forget it for purposes of this discussion.

Core loss is further divided into eddy current loss (due to current flowing in the core material) and hysteresis loss (due to a sort of internal friction in the iron).

The eddy current loss, which may be 25 or 30 percent of the total core loss, is constant for a given applied voltage, regardless of frequency. That is, it goes up as the square of the frequency and as the square of the flux density, but flux goes down as frequency goes up and the two effects cancel. So we can forget about eddy current loss too.

That leaves hysteresis loss. This is propor-

tional to frequency, and to about the 1.6 power of flux density in the working range; it goes up even faster as saturation is approached. But with a properly designed transformer, we do not get into saturation at rated frequency, and at any higher frequency the flux density goes down as we have said.

With constant applied voltage, as frequency is raised the flux drops. The losses drop 1.6 times as fast as the flux, more than taking care of the loss rising with frequency.

To sum up, hysteresis is the principal loss which changes with frequency. At lower than design frequency, it goes up. Even at maximum rated voltage, most 60 Hz transformers will hang together at 50 Hz, but not much below that. At higher than rated frequency, though, the transformer works better and better and even cools off a little. This can be raised to a frequency where leakage reactance and other side effects begin to affect the output voltage regulation. An ordinary power or filament transformer should be good to at least a couple of kilohertz, higher than any power frequency you are likely to find. Even then it won't overheat, only its output voltage will begin to sag under load.

Operating complete equipment

Does all this mean that a piece of gear made for 60 hertz operation can be plugged into a 400 hertz (or higher) source and will go to work without any fuss? In many cases, yes, but there are exceptions. Most receivers have a simple and straight-forward power supply and can be turned on without any worry. Transmitters should be looked at a little more carefully, and test equipment and other auxiliaries should be carefully and individually considered. Several types of components other than ordinary transformers will give trouble on high frequency power, and various kinds of leakage into high gain audio circuits can occur. Before firing up any piece of gear, glance over its circuit diagram for possible trouble spots.

The first thing to look for is AC motors. No AC motor will run well very far from its design frequency; if the equipment is cooled by an AC blower, this will run poorly or not at all and the whole equipment may overheat. One way around this is to rectify the AC and use DC motors. This can cause other trouble, since DC motors have brushes which need periodic attention, and they generate hash which can be very troublesome to filter out. It is possible to run the DC through a transistor inverter and make the proper frequency to run an AC motor. This is cumbersome but has been done in some commercially built equipment. The rectifier and inverter must be efficient, or they may generate as much heat as the blower will remove.

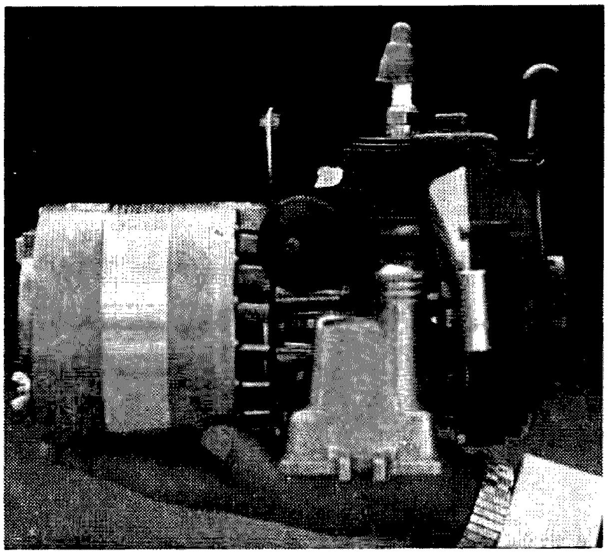
Best of all, pick equipment that uses natural cooling, and leave all the blowers home. Nasty, noisy things!

AC relays are a similar problem. It is comparatively easy to substitute DC relays and rectifiers, though, and the DC relays will be quieter as well.

Voltage regulating transformers are usually of the type whose output voltage tends to be proportional to frequency, thus are not suited to high frequency operation. These are not very common in amateur equipment, fortunately for our purpose. Electronically regulated power supplies using VR tube or zener reference are not affected by frequency, of course.

Once in a while a transformer turns up which, due to unusual secondary insulation requirements, design for current-limiting properties or just plain poor construction, has high leakage reactance. This is just another way of saying it has poor coupling between primary and secondary. Such a transformer will give reduced output voltage under load when operated from a high frequency power source.

Mercury vapor and gas rectifiers have definite frequency limitations, especially when operated near full power rating. Plug-in silicon rectifier replacement assemblies are available and are recommended.



A commercial example of a low cost, high performance, high frequency generator is the Tiny Tor. This light (12 lb.) generator puts out 350 watts of 115 V ac or 6/12 V dc. The ac frequency is around 115 cycles, which makes it useful for most ham gear. The Tiny Tor is distributed by Algert Sales, 1805 Wilshire Blvd., Los Angeles, Cal. Price is $79.50.

These are the principal component-type problems to be expected in amateur equipment. Once you have checked over a piece of gear for situations of this sort, you can hook it up to the high frequency power source with little fear of anything destructive happening.

Problems in operation

Even though nothing burns up, trouble may still pop up in practice. The common high frequency power sources, 400 to 1200 Hz or so, are right in the middle of the audio range, and are much more audible and annoying than 60 Hz. Filter circuits will work better at the higher frequency, so you would expect hum to be less. It may still be a problem in a piece of gear which has lots of audio gain, both because the high frequency is heard better and because the audio system may have reduced gain for 60 and 120 Hz hum frequencies, to get by with less filtering. At 400 Hz and up, any hum will come through at full gain. Hum may also sneak around the filter circuits by stray coupling or by heater-cathode leakage.

One insidious type of coupling occurs if the heater circuit has one side at chassis potential, and is grounded at more than one point. The heavy heater current flowing in the chassis creates a hum voltage of a few millivolts between different "ground" points on the chassis, which can get into sensitive circuits and which no amount of filtering can remove. An aggravated case of this kind is when a separate power supply is used, and the heater circuit is grounded both in the supply and in the equipment, thus putting the heater voltage drop in the connecting cable right in series with the B minus return.

Buzzing of power transformer and choke laminations may be loud enough to be bothersome at the higher frequency. Tightening the core clamping bolts and carefully pushing thin wooden wedges between the core and the coil form may help.

For that matter, it should not be forgotten that the high-frequency generator itself may be quite noisy compared to a 60 cycle unit of the same power. Be prepared to keep the generator some distance away from the operating positions, preferably on the other side of a small hill or in a hollow, and have a suitably long power cord, of large wire so that its voltage drop is not too high.

Another minor trouble that may turn up is that different power supplies in the same unit may change their output voltages by different amounts when running from high frequency power. Choke input supplies will be least affected (if the choke inductance was adequate at the lower frequency in the first place.) Capacitor input supplies will generally increase their output voltage somewhat, and small low-efficiency bias supplies, if unregulated, may put out enough extra voltage to upset the adjustment of a sensitive circuit.

Measurement of line voltage

Another point which is easy to overlook is measurement of the line voltage of the high frequency generator. High quality AC meters of switchboard type will usually not be accurate at frequencies as high as 400 Hz. Such meters will ordinarily have their frequency range marked on the dial. The much-less-expensive rectifier type meters, such as a multimeter on its AC voltage ranges, will do better. It is true that these meters have waveform error, but this should not be of much consequence for this use. As an alternative, check the DC voltage of some of the unregulated power supplies in the equipment. If they show the same DC output under load as they do with 60 Hz power, it is likely that the line voltage is close enough for all practical purposes.

Summary

With a little care, it is quite practical to run most ham equipment on 400 Hz and higher frequency power. This will make a number of surplus and aircraft generators available for use. Automobile alternators should also be usable, taking the AC power off before rectification; some of these are three-phase devices and should have the load distributed equally between phases, so be careful here. I have seen some very cute little portable generators run by a miniature gas engine like a model airplane engine and delivering 200 or 300 watts, which might make high-powered mountain top operation practical.

One last bit of advice—don't leave all the checkup and testing until the last minute. Test all the equipment you intend to use on the actual power source, hooked up the way it will be used. Leave yourself plenty of time to correct any small problems or find substitutes for any equipment that proves unsuitable. If you intend to go mountaintopping, don't forget that gasoline engines have their own little problems at altitude, and may deliver substantially less than rated power. In short, get all the stuff working *before* you head out into the boondocks!

. . . WA6NIL

Technical School for your Ham Training??

Whether or not incentive licensing becomes the law, there are many amateurs who would like to improve their knowledge, either to get a higher license for the satisfaction of it, or as a means of entering the electronics field. Novices and Technicians could find the way to General class licenses more easily by the formal training method, especially where they have no local hams to help them.

The schools listed below are correspondence schools, which means you can work while studying. There is no doubt that you will be a more prosperous citizen with such training. If you have any inclination to get ahead, we urge you to get this schooling. You will be glad you did—and we will be glad, too, if you will mention to the school of your choice that you found their name in 73 Magazine.

Alexander Hamilton Institute
235 East 42nd. St.
New York, N.Y. 10017

American Institute of Engineering
and Technology
1135 W. Fullerton Ave.
Chicago, Ill. 60614

American School
58th St. & Drexel Ave.
Chicago, Ill. 60636

American School of Home Studies
127 Columbus Ave.
New York, N.Y. 10023

American Technical Society
850 E. 58th St.
Chicago, Ill. 60637

Business Electronics
209 W. Jackson Blvd.
Chicago, Ill. 60606

California Electronics & TV Institute
945 Venice Blvd.
Los Angeles, Calif. 90015

Canadian Institute of Science
and Technology
617 Garden City Building
263 Adelaide St., W.
Toronto 1, Ontario

Capitol Radio Engineering Institute
3224 16th Street
Washington, D.C. 20010

Central Technical Institute
1644 Wyandotte St.
Kansas City, Mo. 64108

Christy Trades School
3214 W. Lawrence Ave.
Chicago, Ill. 60625

Cleveland Institute of Electronics
1776 E. 17th Street
Cleveland, Ohio 44114

Commercial Trades Institute
1400 W. Greenleaf Ave.
Chicago, Ill. 60626

Coyne Electrical School
1501 W. Congress Parkway
Chicago, Ill. 60607

Delehanty Institute
115 East 15th St.
New York, N.Y. 10003

DeVry Technical Institute
4141 Belmont Ave.
Chicago, Ill. 60641

DeVry Technical Institute of Canada
970 Lawrence Ave., W.
Toronto 19, Ontario

Elkins Institute of Radio and Electronics, Inc.
4119 E. Lake St.
Minneapolis, Minn. 55406

Grantham School of Electronics
1505 N. Western Ave.
Hollywood, Calif. 90027

Heald's Engineering College
Van Ness at Post
San Francisco, Calif.

Indiana Home Study Institute
Box 1189
Panama City, Fla. 32402

Indiana Home Study Institute
Eastern Division
Box 282
Saxonville, Mass. 01256

Industrial Training Institute
2150 Lawrence Ave.
Chicago, Ill. 60625

International Correspondence Schools
Scranton, Penna. 18515

Massey Technical Institute
148 E. 7th St.
Jacksonville, Fla. 32206

Milwaukee School of Engineering
1025 N. Milwaukee St.
Milwaukee, Wis. 53201

National Electrical and Television School
1298 Niagara St.
Buffalo, N.Y. 14213

National Radio Institute
3939 Wisconsin Ave.
Washington, D.C. 20016

National Technical Schools
400 S. Figueroa St.
Los Angeles, Calif. 90037

Northrop Institute of Technology
1199 W. Arbor Vitae
Inglewood, Calif. 90301

Northwest Schools
1221 N.W. 21st Ave.
Portland, Ore. 97209

Pacific International College of
Arts & Sciences
5507 Santa Monica Blvd.
Hollywood, Calif. 90038

Philco Technological Center
C and Ontario Sts.
Philadelphia, Pa. 19134

Port Arthur College
Box 310
Port Arthur, Texas 77641

Radio Television Training of America
52 East 19th St.
New York, N.Y. 10003

RCA Institutes
350 W. 4th St.
New York, N.Y. 10014

Sprayberry Academy of Radio-Television
1512 Jarvis Ave.
Chicago, Ill. 60626

Tri-State College
2436 College Ave.
Angola, Indiana 46703

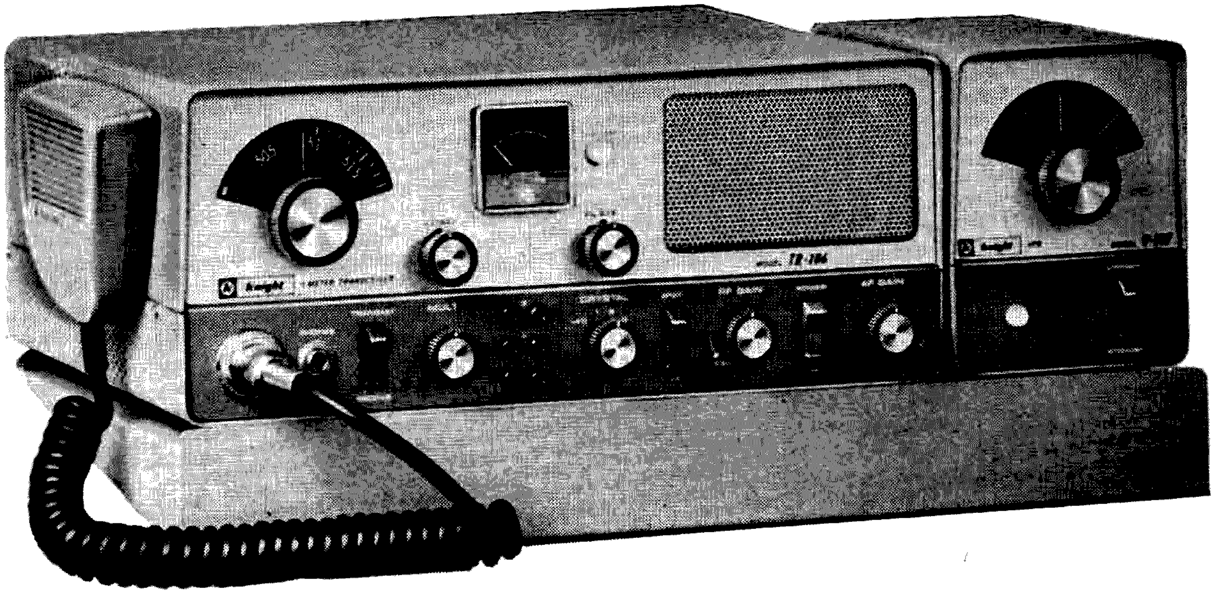
Valparaiso Technical Institute
Valparaiso, Indiana 46383

Using the Tunnel Dipper on 432

Recently I contemplated building some gear for 432 MHz. Like many other hams I had invested in a 432 MHz converter to copy Oscar IV; but when I found out what a "Yo-Yo" it was I gave up building the big array with tilt and went back to my 144 MHz construction. Then I thought, "With a $55.00 converter on hand why not put a transmitter on the air?" With no feel for 432 some sort of dipper was necessary. From some recent articles I could have built one in two or three evenings; but time is at a premium at this QTH.

Heath says the Tunnel Dipper is good to 350 MHz. I made a coil of #16 wire —$\frac{5}{16}$" ID on an RCA phono connector. This coil acts as a wavemeter and dipper at 432 MHz just wonderfully. With my coil 404 MHz appears at 4.50 MHz on the red scale and 432 MHz appears at 260 MHz on the white scale.

. . . Fred Grant K6YWE



The Knight-Kit TR-106 and V-107

Knight's new six meter transceiver and matching VFO make a nice pair for six meter hamming.

Knight recently announced a new six meter transceiver kit, the TR-106, and matching VFO, the V-107. It looked like a rig many of our readers would like to know more about, so I got one to put together and try out. I found that it's a nice piece of gear and a lot of fun to build and use.

Knight-Kits have always been among the easiest kits to build. Their instruction manuals are excellent. Knight supplies pre-cut, pre-stripped and pre-tinned wires, and even expensive eutectic solder to help prevent cold solder joints. Part of the receiver—the critical first converter, was furnished pre-wired and aligned. It only took a few nights to build the kit and the alignment was a snap, too.

TR-106 Specifications

Receiver Section:
- Audio output: 5 watts or more
- Intermediate Frequencies: 15.6 to 17.6 MHz; 1650 kHz
- IF rejection: 50 dB or better for first if; 70 dB or better for second if
- Image Rejection: 55 dB or better
- Input Impedance: 50 ohms nominal
- Frequency Range: 50-52 MHz
- Selectivity: 6 dB down at 8 kHz
- Sensitivity: .5 μV for 10 dB S+N/N ratio

Transmitter Section:
- Frequency Control: 8 MHz crystals or VFO
- Frequency Range: 50-52 MHz
- Output Impedance: 30-90 ohms
- Power Input: 15 watts

Power Supply:
- All Solid State: Transistor oscillators and silicon rectifiers
- Power Requirements: 120V, 60 Hz, 90 W; 12-15 V DC, 6.8 A receive, 8.1 A transmit

Miscellaneous:
- Size: 5½ x 13⅛ x 11"
- Price: $139.95

The TR-106 and V-107 use well-tested, straightforward circuits. No tricks here. The transmitter oscillator uses 8 MHz crystals or the V-107 VFO and the exciter is bandpass coupled to the 2E26 final amplifier. Modulation is high level plate and screen with automatic limiting to prevent overmodulation. The push-to-talk microphone is included.

The receiver section of the TR-106 is a double conversion superhet with a neutralized Nuvistor rf amplifier. The first oscillator is crystal controlled. Selectivity, rejection of unwanted signals and sensitivity seem excellent. An rf gain control, to help prevent overloading, switchable ANL and a spot switch are among the controls. There's no BFO, but you can use the VFO for one on strong signals.

The built-in solid state power supply can be operated from either 115 V or 13.5 V.

The V-107 VFO plugs into the TR-106. It uses a one tube oscillator with voltage regulation and temperature compensation. One of its clever features is that you can use it on either six or two by changing the position of the dial plate and realigning the oscillator.

V-107 Specifications:

Frequency Coverage: 8.333 to 8.666 MHz for 6 meters
8.000 to 8.222 MHz for 2 meters
Frequency Stability: ±500 Hz per hour after 30 minute warm up
RF Output: 20 volts rms minimum into 47 k shunted by 30 pF
Power Requirements: 200 V DC, 30 mA, 12.6 V, .15 A
Size: 5½ x 4¼ x 6½"
Price: $19.95

The instruction books discuss theory of operation in stage-by-stage form, installation, alignment, troubleshooting, TVI hints (though I didn't notice any TVI), cleaning up car electric systems, antennas, mobile installation, and propagation. Among the accessories available are a mobile mount and the desk mount shown in the photo above.

After the pair were finished and had been checked on the scope and other instruments, I took them up to Pack Monadnock for a test. I just used a simple dipole, but found the band full of signals. The TR-106 had no trouble separating them, though. A quick call was answered by a near-by station who reported excellent audio. After signing with him, I talked to other stations over 150 miles away. They all agreed that the signal sounded fine, was over S9, and had no drift. The Knight TR-106 seems to be an excellent buy and a lot of fun. You should consider it carefully if you're interested in six; I think we're going to be hearing a lot of them.

. . . WA1CCH

I feel like a spider.

John Schultz W2EEY/1
40 Rossie Street
Mystic, Conn. 06355

A Curtain Going Up

Build an easy-to-construct curtain array and work that DX!

Many amateurs who have the space to erect an elevated 40 meter dipole can improve the performance of their antenna system on several bands and at minimum cost by erecting a small curtain-type array. The advantages of curtain arrays in general are discussed and several construction hints are given as worked out by the author while constructing a small Bruce array.

I transported my 20 meter beam to my new QTH, but because the house was surrounded by high trees, roof top mounting would not be effective. I didn't want to invest in a tower, so I would have to find another solution to the antenna problem.

Perhaps because of my recent association with Radio Free Europe, where a large number of modified curtain-type antennas are used for transmitting. I thought of using this type of antenna. Curtain arrays have a long history of use as commercial DX antennas. They were extensively used in the 30's for instance, for trans-Atlantic telephone service. Sterba curtains for transmitting and Bruce curtains for receiving were normally employed. However, such antennas have never been used much in the amateur field because most amateurs think that such arrays must be huge to be effective. However, even small curtains giving only moderate gain can, under the right circumstances, be an ideal amateur antenna for fixed direction work. Assuming some sort of natural support, such as trees, are available, the only investment is in wire and insulators. Most curtain designs can be used on two or more bands, by using a resonant feed line, and the direction of maximum radiation usually remains the same on different bands.

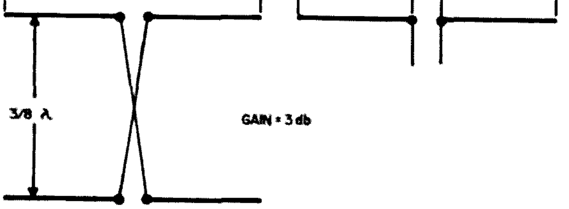


Fig. 1. Simple broadside and colinear antennas having about the same gain.

Curtains vs. long-wire antennas

Perhaps one reason why curtains, or broadside arrays in general, are not given too much consideration by amateurs is that when one looks at the gain figures for a small curtain as compared to a long-wire, the additional construction effort hardly seems worthwhile. For example, compare the gain of an elementary broadside array (stacked dipole) against a full wavelength (double Zepp) wire **Fig. 1**). Both antennas give the same gain, about 3 dB, but the broadside array is certainly more difficult to construct and support than a simple length of wire. However, the gain figure alone is deceiving unless one understands how the gain is actually achieved.

Any directive antenna, from a dipole on up, concentrates radiation in various directions. This concentration or "directivity" takes place in the horizontal and/or vertical planes. Colinear antennas, such as a long-wire, achieve gain almost solely by horizontal directivity.

John is a Civil Service Engineer with the U.S. Navy. He has a BEE from Polytechnic Institute of Brooklyn and has written a number of articles for many radio magazines.

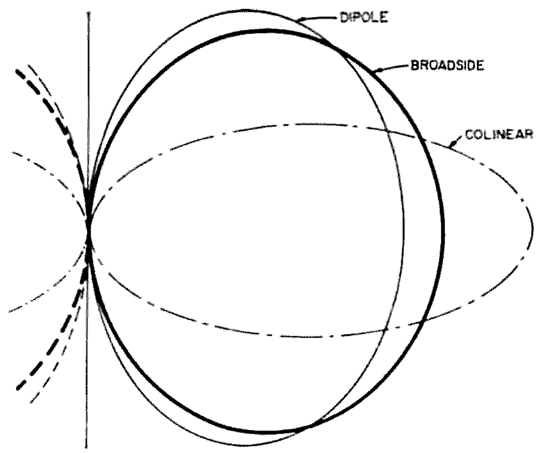


Fig. 2. Horizontal directivity patterns (only half shown.)

That is, as the antenna is made longer by the addition of correctly phased half-wave sections, the horizontal pattern (**Fig. 2**) becomes sharper and sharper. The vertical directivity (**Fig. 3**) remains, however, essentially the same as a half-wave dipole. Note what happens with a curtain. It achieves gain mainly by vertical directivity. That is, its horizontal pattern remains broad but for the elevation shown in **Fig. 3**, for instance, its vertical pattern is far superior to a colinear array. Radiation is more concentrated at the lower angles effective for DX. The point is that in a limited space one definitely ends up with a more effective DX antenna with a curtain although its gain is not more than a simple colinear antenna.

The two most common and useful types of curtain arrays are the Bruce and Sterba (**Fig. 4**). Both arrays are high-impedance devices.

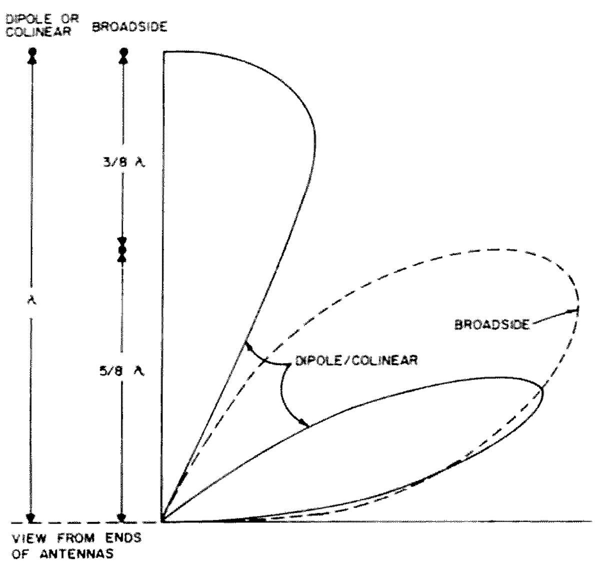


Fig. 3. Vertical directivity patterns.

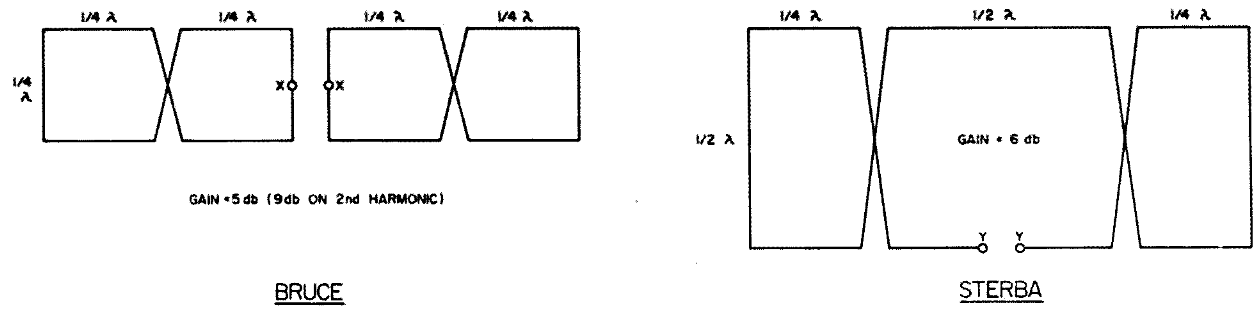


Fig. 4. Bruce and Sterba curtain dimensions. For best results the lower element of each antenna should be elevated ¼ to ⅝ wavelength above ground.

The dimensions are not critical, and if fed with a non-resonant line for one band operation, a low SWR will result over the entire band. Both arrays may be used for multiband operation (on 10 and 40 if cut for 20 meters, for instance). The Sterba array will give slightly more gain on its design band and better performance at half-frequency compared to the Bruce array.

The feed-point impedance of the Bruce array (xx in **Fig. 4**) on its design band is 750 ohms and the Sterba shows about 300 ohms (yy in **Fig. 4**). Either antenna can be fed with a flat 72 ohm transmission line for one band operation by using one of the matching transformers shown in **Fig. 5.** For multiband operation, 300 ohm twin-lead can be used as a resonant feed line for powers up to 600 watts PEP.

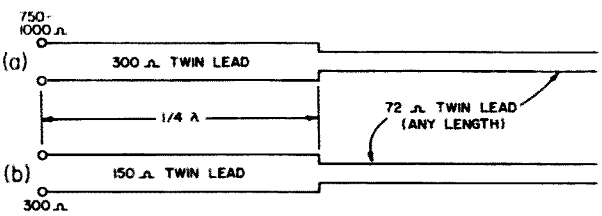


Fig. 5. Simply constructed matching transformers that can be used to feed a Bruce or Sterba curtain for single band operation.

I decided to construct a Bruce array as best fitting into the space I had available. In my first attempt at construction of the array, I made all the elements from 7 x 20 stranded wire with insulators as necessary at the crossover points between bays. Upon erection, however, I quickly learned that unless extensive rigging is used or a great number of insulators put in, the crossover lines between bays will easily twist together. I then reconstructed the array using 300 ohm twin lead, twisted one turn, for the crossover lines between bays. This greatly simplified the construction and appears not to degrade performance. **Fig. 6** shows the antenna dimensions for 20 meters. The twin-lead ways taped to the spacing insulators as shown in **Fig. 7.**

The antenna was first constructed in the basement with the elements rolled together and then the assembly laid on the ground and hoisted into position. The springs shown in the upper guy line are 6" compression units ($0.35 in boat supply houses). The springs are absolutely necessary to prevent wire breakage if the guy ropes run over the upper limbs of trees which sway to any degree during bad weather. The feedline should be run away from the array at right angles for a half wavelength or so if possible.

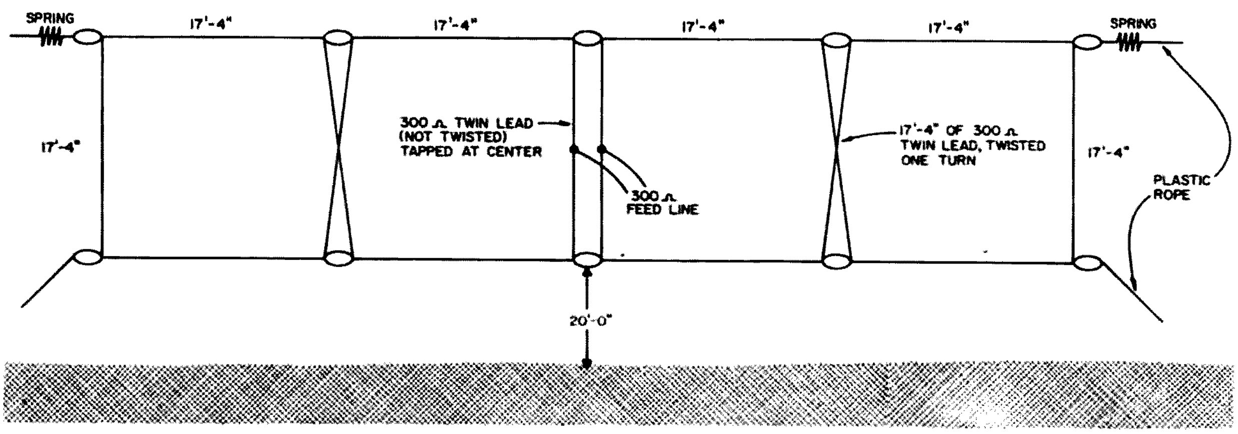


Fig. 6. Dimensions for the Bruce array for 20 meters

I fed the array for one band operation using the matching transformer (a) in Fig. 5. SWR was not worse than 1.2 to 1 over the entire band.

Construction of a Sterba curtain should easily be possible using the same construction techniques.

For the investment in parts, probably no other antenna gives so much value. My antenna was oriented for Europe. Signal reports have been consistently good and certainly equal, for the same transmitter power, reports received by other stations using three element beams at the same average elevation (29′) as the curtain.

. . . W2EEY/1

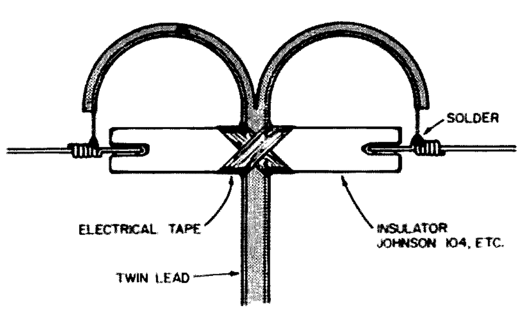


Fig. 7. Simple method of fastening twinlead to insulators.

Seen at the Disneyland ARRL convention: WN6SSZ, Mary Lou Stockstill, a deaf and blind amateur who communicates via CW over the air and by Braille-writer in person. Mary Lou speaks very well and is a truly amazing person. Talking to her here is Bill Welsh WA6VTL. Next to Mary Lou is Ray Meyers W6MLZ, the past director of the division, and talking with him is Dave Abramowitz WB6JEV who, years ago, in his SWL days, used to come bouncing over to my house in Brooklyn on his bicycle.

(Continued from page 2)

a letter from the safari outfit saying that they had made a little mistake and couldn't take us the first of August as planned . . . could we make it July 15th instead. Oi. I called Jim Cotten W5PYI and Larry Frank WA6TCI, who had answered my editorials asking for volunteers to go on the trip and found that they could somehow change their plans and start two weeks early.

The visas are a whole galaxy of problems in themselves. You see, before you can get into most countries, you have to have a little stamp in your passport issued by the consulate for that country giving you permission. This can be rough. The fees, even for a one day visit, run up to $5 and over. Then you have to have a health certificate for some showing that you are prepared to ward off yellow fever, small pox, typhoid, tetanus, cholera, plague, typhus, and other darbs. Most of them want you to fill out one, two or three forms, complete with photographs. Most of them want to look over all this, along with your passport, for 24 hours . . . or longer. Sudan requires three days and Burma wants six months if you are going to stay more than 24 hours in the country. A letter from your local police chief attesting to your character is required by some . . . and several want a letter from your travel agent saying that you have a ticket to get you out of their country and enough money to take care of yourself during your visit.

The 23 countries we planned to visit looked like a six months visa program . . . and I only had a few weeks, so I hopped down to New York and went around personally to get forms from those consulates who hadn't bothered to even answer my written request. There is no way to describe the frustration of this process. I had to start out by visiting the U.S. Passport Agency to get my passport extended for another two years since it was scheduled to run out the day after our return . . . and several countries won't issue a visa unless the passport is good for at least six months after your visit. Our agency has a very hot and incredibly crowded office in Radio City. I picked a short line so I only had to stand there for a little over an hour. I slipped them a dollar extra to get them to rush things and I was thus able to swing in the next afternoon and pick up the passport. Nice, but since most of the consulates and U.N. mission offices close at I PM, it was too late to get any visas that day.

The next morning I got right over town and started with the last stop, Tahiti. Since a number of countries won't issue a visa unless you already have one for the next country it seemed prudent to work my way back up the list. The French Consulate handles Tahiti. I handed over all the forms, the payment, the photographs, and my passport. How long was

Don W9WNV/everywhere showed at the Anaheim convention and flabbergasted all with his slides of recent DXpeditioning. He has been working his way across the country visiting DX clubs on his way down to Heard Island. Watch for an interesting series by Don in 73 when he gets through traipsing. Since all of you DXers have worked Don, we thought you might like to see what he looks like.

James Ashe W2DXH
R.D. 1
Freeville, N.Y.

Another Look at the Like New Circuit

A low distortion low noise mixer for those who use tubes

It's always nice to find a better circuit. Improving the operation of a piece of gear is in more ways than one a rewarding activity. And also in constructing new homebuilt items a new circuit may mean the difference between poor and good performance or enable the builder to eliminate a tube or two.

A very good practice before firmly committing yourself on a new circuit is to try it out on a breadboard. With a little care its normal operating conditions can be approximated well enough to give a good idea what it will do when installed in the finished chassis. Experience gained during breadboarding is likely to be valuable during the final debugging session and helps in planning circuit layout.

Simple circuits, if they will do the same job, are generally preferable to complex ones. One such circuit is the Like New circuit presented in the October 1961 issue of 73 Magazine. This uses a twin triode to replace the complex and noisier pentagrid converter. Requiring a simpler tube and only one supply voltage, it offers the same or better performance. A good trade!

But the circuit as originally presented seemed to suffer from two shortcomings. These were, loading of the local oscillator and a question of its stability with tube and component aging.

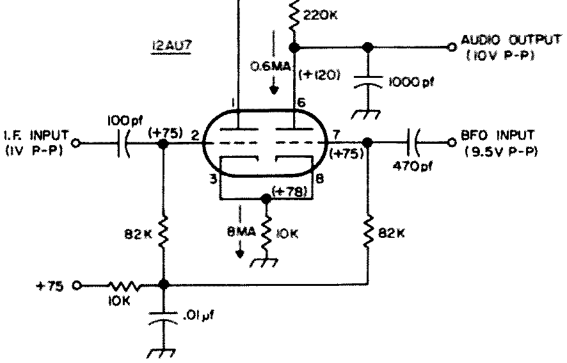


Fig. 1. Modified Like New mixer circuit.

With the local oscillator grid resistor returned to the cathode rather than ground, there is no bias on the second triode unless the local oscillator is running. The bias comes from grid rectification so there is some loading on the oscillator.

The small resistor carrying cathode current has little control over how much current is flowing. If the vacuum tube properties change, so must the cathode current and the operating point.

This circuit looked like a good bet for a project of building a specialized receiver. It was not clear how it worked, but the glowing description was most encouraging. So a little thinking about it brought out the idea that it was very similar to a difference amplifier and as such might turn out to be a real linear mixer.

To make a long story short, it is not a linear mixer. The circuit, to work properly, must have a nonlinear element: the plate characteristics of the second triode appear to be in a region where an approximate square law transconductance rule holds. Of this more later.

Fig. 1 is a diagram of the completed circuit as used. Although it looks rather different from the original Like New circuit, the changes are really only skin deep. It is arranged to have improved resistance to overloading, better bias stability, and does not require any power from the local oscillator to generate its bias voltages.

The biasing system will look strange to the amateur eye. It is not a conventional practice to operate grids at plus 75 volts and use great big cathode resistors. However, this works out well.

The values shown are those that were obtained using a 12AU7 twin triode and the circuit resistances shown. Also indicated are circuit currents and the peak to peak values of the signal voltages. Both inputs were slightly

I going to visit Tahiti? Five days. Oh, you don't need a visa for any visit under ten days. She didn't know why there had been no mention of this in the instruction sheet I'd been sent.

I hiked up and down Manhattan for several days, gradually getting more and more visas stamped in my passport. Finally I gave up, seeing that this was going to string out for two weeks or so longer and I dug up a travel agency to take over the foot work from there. As a rule of thumb I would say you should allow at least one working day for each visa you are going to need for a trip.

Below is the schedule for the trip. We'll be getting on the air from every stop we can manage . . . you might keep an ear peeled on 14230, since this is a favorite frequency of mine. While I've made arrangements in a few places to see local ops, I would appreciate it if you would keep my schedule handy and let amateurs in any spot we'll be visiting know when and on what flight we will arrive so we can have a chance to meet them.

There will be just two of us on the round-the-world flight. Jim Cotten W5PYI and myself. WA6TCI will be on the safari, but has to get back earlier and thus has to pass up the long flight.

. . . Wayne

Itinerary

	Date	ETD	ETA	Flight
Boston to Rome	12 July	2100	1030	AZ 623
to Nairobi	13 July	1220	2215	AZ 518
to Addis Ababa	20 Aug.	1340	1525	MS 760
to Khartoum	22 Aug.	1100	1125	ET 781
to Cairo	23 Aug.	0900	1125	SD 102
to Beirut	24 Aug.	2130	2140	ME 301
to Baghdad	26 Aug.	1930	2200	ME 320
to Tehran	29 Aug.	0940	1125	IR 406
to Kabul	31 Aug.	0500	1030	FG 204
to New Delhi	1 Sept.	0800	1200	FG 302
to Katmandu	3 Sept.	1300	1640	RA 040
to Calcutta	5 Sept.	1535	1830	IC 248
to Rangoon	7 Sept.	1210	1605	IC 295
to Bangkok	8 Sept.	1400	1545	TG 302
to Singapore	11 Sept.	1820	2055	QF 740
to Perth	13 Sept.	1935	0105+1	BA 712
to Melbourne	15 Sept.	1315	1940	TN 507
to Sydney	17 Sept.	1000	1125	AN 308
to Aukland	20 Sept.	1000	1442	OF 852
to Noumea	28 Sept.	1100	1455	TE 402
to Naud	28 Sept.	1455	1740	UT 1586
to Suva	29 Sept.	1715	1800	FJ 132
to Apia	1 Oct.	0800	1310+1	FJ 952
to Pago Pago	1 Oct.	1700	1745	PH 266
to Papeete	4 Oct.	1500	1850	PA 809
to Los Angeles	7 Oct.	0900	2010	UT 1588
to Boston	9 Oct.			

IMPORTANT PROGRAMMED LESSON

Please follow instruction carefully.

1. I received this copy of 73 in the mail. Yes ...... No ......
   If the response is Yes, please continue to item 2.
   If the response is NO, please see A below.

2. I live in a place with U.S.A. mail delivery. Yes ...... No ......
   If the response is Yes, please continue to item 3.
   If the response is No, continue to another feature in this 73.

3. The wrapper this 73 came in has the proper zip code on it. Yes ..... No .....
   If the response is Yes, please continue to another feature in this 73.
   If the response is No, please write the proper zip on the part of the wrapper with the address on it and send to Linda, c/o 73, Peterborough, N.H. 03458.

4. I paid 60¢ for this copy of 73 at a radio dealer or newsstand.
   Yes ...... No ......
   If the response is Yes, you paid almost twice as much for this as a one-year subscriber. He pays about 33¢. A two year subscriber pays less for two years than a newsstand buyer does for one. Continue to item 5.
   If the response is No, you are a freeloader. Continue to item 5.

5. Please fill in this information:

   Name .... Call ....

   Address ....

   City .... State .... Zip ....

   Then continue to item 6.

6. Please tear this sheet out of the magazine. Place it with a check or money order for $4 in an envelope addressed to 73, Peterborough, NH 03458 and mail.

Congratulations. You have completed the programmed instruction correctly. The first of twelve certificates of achievement will reach you in six to eight weeks.

below 6 MHz, with frequencies a few hundred cycles apart. It was used as a second detector, conversion of an *if* signal to audio.

A good place to start in discussing this circuit is the biasing system. A constant-current or long-tailed bias network sets the tube operating points. This name refers to the large resistor from cathodes to ground, which determines the tube current. An indication of how powerful its control is may be found by supposing the tube current to be momentarily disturbed by a 1 mA increase.

This will produce a 10 volt voltage change on top of the resistor. With a transconductance of around 5 mA/V, the 1 mA increase in current will cause the tube to turn off about 50 mA. If any change in cathode current is countered by a change 50 times greater in the opposite direction, the long-term stability of the current will have to be pretty good.

This resistor is selected by, first, deciding how much current is to flow. Then a convenient grid voltage is decided on—something like ten times the anticipated grid-to-cathode voltage is a good choice. This sets the cathode voltage roughly and a plate characteristics

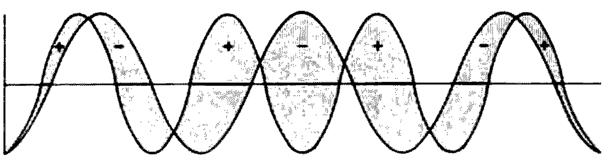


Fig. 2. Result of perfect addition of two sine waves of slightly different frequency, but the same amplitude.

chart together with an educated opinion about the anticipated size of the anode resistor locates the quiescent point which in turn locates more exactly the grid to cathode voltage.

The cathode must be positive with respect to the grid. So the required bias voltage is added to the previously fixed grid voltage, which gives the cathode voltage. The cathode voltage is divided by the cathode current to obtain the size of the cathode resistor—and there you have it. With this resistor in place, the anode current will show considerable resistance to being changed by various sizes of anode load resistance.

Since the grids do not draw any current, a resistance divider carrying a mil or so supply lines can fix the grid voltages. But in order to avoid coupling from one grid to the other through the bias network, there should be a generous bypass capacitor to ground.

Now let's look at what goes on in this circuit. There are two conditions to consider: DC conditions with no signal at all on either grid, and the slightly revised operating conditions when signals are coming into both grids. Since these conditions are not very different, it is simplest to discuss only the operating conditions.

Although both cathodes are connected together and both grids are biased to the same voltage, the two triodes are in very different parts of their operating regions. There is over 7 mA flowing through the left triode and about 0.6 mA flowing through the right one. This is because of the difference in plate voltages: most of the current is going to the triode with highest anode voltage. Consequently the LH triode is a strong, healthy cathode follower and the RH triode is a weak, nonlinear amplifier working into a very large load resistor.

Fig. 2 shows why this is required for best operation. The two sine waves are of slightly different frequencies. The chart is constructed by drawing them both same size and shading in the area between them, marking these areas plus when one curve is on top and minus when the other is on top. This situation repeats itself periodically and may be charted out to extremely long times if desired. However the main ingredients of the situation appear quite early.

Namely, if we use a circuit that puts out the exact instantaneous difference voltage of these two frequencies, the output isn't going to be of much value. But if somehow one kind of difference—say the one labeled plus—can be emphasized over the other, the result will be a signal emphasizing the real difference

between the two frequencies.

This explains why the second triode must be operated at a very small plate current. In this region it is near cutoff and its curve of plate current as a function of grid to cathode voltage is strongly curved. If the grid to cathode voltage goes more negative, the anode current can change only a little—if it goes more positive, the anode current can increase considerably.

In short, this circuit is a nonlinear amplifier of the difference between two frequencies. I have to admit to Jim Kyle that my previous understanding of how this circuit worked was wrong!

This leaves only the function of the second anode bypass capacitor to discuss. It is necessary to bypass RF from the second anode to ground. In another way of speaking, it smooths out the anode current so that the following circuit sees only the average current. It does not need to be a very large capacitor since the second triode has a high output resistance and it would not be very hard to bypass its entire output to ground. A properly chosen capacitor can give a rolloff curve to de-emphasize the higher frequencies, a simple step for reducing the effects of noise.

As it is presently being used, this circuit gives good gain, is immune to the blocking effects of noise, and appears to be as good as it is supposed to be. It makes a much better second detector than the converter tube it replaced. With appropriate revisions it can be used as a first detector which brings us full circle since that is the originally described application!

With this circuit available, the amateur builder can develop and build a really good receiver with only one or two kinds of tubes —all triodes. For instance, the input RF amplifier would be a cascode. This would feed some version of the 73 mixer circuit, with a triode local oscillator. From here we would go to a crystal *if* as described in the April 1961 issue of 73. This would then feed a twin triode circuit similar to that just described, and one or two more triodes would make up the output stages.

If this were properly done, only three tuned circuits would be required in the entire receiver. They would be, the input circuit, the RF to mixer interstage coupling, and the local oscillator tuning circuit. The BFO would be a crystal oscillator. For the higher frequency ham bands or as a narrow-range receiver fed by a converter it would be necessary to tune only the local oscillator. The first *if* input? Use a resistor! Think about it—it can be done!

. . . W2DXH

Gus Browning W4BPD
Orangeburg, S.C.

Gus: Part 14

In the last installment I was on the Seychelles, getting ready for my trip to the Aldabra Islands. You would be surprised to see the number of different things that have to be done when you are preparing for such a trip. For one thing the word had got out on Mahe that we were going to be on our way in a few days. Everyone who had any relations on any of the other islands along the way all gave us mail and other items to be dropped off along the way, and some fresh food was also taken. This made a good sized little pile of items to be placed upon the boat. This along with the supplies we would need just about filled the boat to the brim. We even took along quite a number of live chickens, looked like we were going on a sort of "chicken eating" DXpedition, which is a very common thing for a Baptist. But evidently the Catholics also practice this business of "chicken eating," since the Seychelles are predominantly Catholic, I suppose something like 98%.

Harvey was busy getting his "wind charger" oiled up and in good working condition since his equipment at that time was mostly of the 12 volt DC variety. All day and all night he had the wind charger going full blast charging his various batteries, he wanted to start with all of them fully charged. Jake (the owner of the Lua-Lua) was busy seeing that his little diesel was in tip top condition. While all this was going on I was quite busy myself getting my "putt-putt" mounted on the rear of the boat with the exhaust sticking out towards the rear so the noise would not disturb Harvey and Jake when they wanted to sleep. The rig was strapped down on the eating table so that it would not slide off in case of rough seas. NOTE—Be sure to have a very good, wide, deep funnel to pour your gasoline into the putt-putt because those high winds and pitching boat can cause you to lose lots of gas.

When everything was placed on board, all fastened down, and we were ready to go, the harbor safety man came aboard to look everything over before he gave us our final clearance. These safety men are very careful and do a good job; you don't fool these fellows at all. We three got on board early in the morning, and of course Harvey had his fish-eating black cat along with him as I knew he would. Harvey doesn't go anywhere without his black cat, and a big supply of tea and hard tack. that seems to be "the staff of life" to Harvey, (and it turned out that it was also our staff of life). You should have seen the gimbal-mounted gasoline cook stove, which would stay level if the boat pitched any direction. Both Harvey and Jake had their sextants and their own charts along with them; Harvey also had his pair of FB field glasses. Harvey predicted that the seas were going to be rough, and we found out that Harvey was 100% correct.

After a last minute check-up on everything, and another round of tightening up all ropes on the items in the hold of the Lua-Lua, we were ready to lift anchor and be on our way to Aldabra Islands. The three of us—Harvey, Jake (the owner of the Lua-Lua) and I, along with Harvey's black cat, went aboard. The little diesel was cranked up, the anchor lifted, and all ropes taken in from the dock. We backed the boat away from the pier and the gear was shifted into "forward" and we were off for the Aldabras, the islands of giant turtles, thousands of birds, and BEST OF ALL A RARE DX SPOT. This was one DXpedition

I firmly had made up my mind NO ONE was going to make us turn back from. After reaching the deep channel the sails were raised and the diesel cut off, and from then on it was a sail boat. Usually the diesels on these boats are used for landing and departing, basically this was a sail boat. This little Lua-Lua had a very deep keel and, for its length, a high sail. According to Jake it was practically impossible for this boat to capsize. I for one hoped he was right. I knew the boys all over the world, and especially back in the States, were all QRX for this brand new country I so badly wanted to put on the air.

As usual the first few hours out from Port Victoria sailing was very smooth since we were pretty well shielded from the big swells of the ocean by Mahe island. I fired up the rig and let loose with my first CQ signing VQ9A/MM and had one of the doggondest pile-ups you ever heard. Everyone wanting to know when would we arrive at the Aldabras. Considering the fact that the sunspot cycle was not at its best, the way signals came thru really fooled me. I hoped conditions would stay like that when we got to the island. The band (14mc) stayed wide open almost around the clock. I suppose being nearly on the equator did make a big difference. It was agreed before we departed that each of us would take his turn at the wheel. But with conditions so good on the air my turn at the wheel never did come up because I was very QRL when it did. So in the end the chore of handling the wheel was always Harvey's and Jake's. An issue was never made about this so all the way down I got in plenty of operating.

When we finally got out from the shadow of Mahe Island into the deep blue sea all the smooth sailing changed to just the opposite. Each wave had its own white cap, the swells were wide apart and the little boat would glide down into each valley of those swells and then all you could see was water looking like mountains all around the ship. Those big sails put the boat into 45 degree lean nearly all the time. I soon found out that this fellow Jake was about as good a sailor as Harvey. This was going to be a Good DXpedition I could see. I used to watch the little stove going back and forth, and then side to side, everytime the boat tossed or pitched. It was hard to believe that the tea kettle would sit on that stove with so much motion.

Harvey's black cat was very busy as usual scampering all over the deck looking for flying fish. Harvey kept one eye on his cat and the other on the compass when he was on the

wheel. We all were having a very fine time, and everything was going smoothly. Harvey was always looking for one of those "stormy petrels," small birds that skim the tops of the waves, sort of following the boat, which according to him indicated bad weather was coming. So far we had not seen any of them, but we did see plenty of other birds. At times we saw a great many birds, especially when one of them spotted a school of fish. Suddenly from out of nowhere would appear hundreds of birds. They dived into the school, each of them squawking just before it hit the water. There would be a steady stream of these birds pouring into the school of fish, and another stream flying back into the air so they could hit the water again and catch another mouthful of fish. Occasionally we would see a whale in the distance. They could be easily spotted when they came to the surface to "blow."

Thank goodness there was no sign of seasickness on board this time. The toilet was flushing OK and even the bilge pump was working properly. Each of us had his own little cabin down below deck with his own private port hole. The bunks were pretty well padded and had good high side boards so we would not be tossed out when the ship heeled far over. My bunk was just the right length so that I could wedge myself in and not slip and slide from foot to head when the boat pitched back and forth. Things can get pretty rough when you are about a foot too short for your bunk and you start sliding back and forth with the movements of the boat. Specially me with my practically bald head. Give me a bunk that's my exact length every time in rough seas. The sideways motion of the boat was better than sleeping pills to put you to sleep. I mean when the swells were wide apart and the motion was like clockwork. At other times when the sea was not in a good mood, getting to sleep was a problem. The further South we went the more vicious the seas became. But still no sign of seasickness which was FB with us all. Even Harvey's cat did not get seasick as it did on our attempt to sail to Agalega on the other trip. OH, YES! cats do get seasick—at least Harvey's black cat did. It's sort of messy too and smelly. A seasick cat—ug UG UG. I wonder if fish ever get seasick? Hi! Hi!

After 3 days at the wheel both Harvey and Jake were pretty well pooped out, so when we pulled into the coral reef that's all around Desroches Island and delivered the mail there, we waited so that the people who received mail could answer it. We walked around the island, had a fairly good meal and back to the boat with the outgoing mail. We arrived on board a little before sundown. Harvey and Jake decided to spend the night inside the coral reef and get some rest from their turns at the wheel for the past 2 days. Just when it got dark, down to their cabins they went for a long night's rest. For myself I cranked up the little putt-putt and went on the air signing VQ9A/MM. 20 meters stayed open until about 2AM. Down to my little cabin I went after turning off the power plant. Since the boat was pretty well screened by the island there was very little air moving down below deck. So I decided to sleep out under the stars on one of the padded portions of the rear deck. Both sides were padded and comfortable, one on each side of the boat with the wheel in between the two. It seemed as if I were going to have a nice quiet sleep out under the stars. After lying down and doing a little thinking, I wondered what my wife Peggy was doing at that very moment; if the phone patch net across the USA would be ready to go into action when I arrived at Aldabra, and what channel "A" were saying to each other. I also wondered why they did not count Desroches as a new one (not knowing that one day it would be a new one). I could have so easily gone ashore and had some nice pile-ups, and told everyone to date his QSO for late 1966 so that they would have themselves a new one. Hi, Hi. When you are lying on the topside of a small boat at anchor late at night so far from home you have time to think of a lot of things. For a while I even watched to see if there was any flying saucers anywhere around. When I did finally get nearly to sleep, it seemed as if I were hearing some sounds that I had not heard before; the boat seemed to be moving a little bit more than it had before. For a while I just lay there listening very closely and SUDDENLY I DID HEAR some strange sounds like a wet mop was being dragged across the boat somewhere near me, and then I started to hear some sucking sounds, sort of like something was trying to suck water from a bottle, something that had about 6 or 7 mouths at the same time. As my eyes had become accustomed to seeing in the starlight, I sort of opened them both, not knowing what I would see, and looked right across from where I was and only about 6 feet from me there was something that looked like an elephant trunk moving around the other padded seat right across from me. I let loose a loud yell, and some unprintable words probably along with the yells. Jake and Harvey came tearing up the steps from below and one of them yelled "It's an

octopus." They grabbed some oars from the life raft and began to pound and pry loose that elephant-trunk-looking thing, finally it came loose and was tossed overboard. Then they told me there was 7 more of those tentacles that would have whipped onto the deck if that one I saw had found something to wrap itself around. I was sure glad that the one I saw had picked the left side of the boat instead of the right-hand side where I was lying. This could have brought this DXpedition to a sudden stop. After things sort of quieted down I went to my cabin this time, and even shut the door and my porthole too. I forgot all about how hot it was down there. But I never did go to sleep. Every movement of the boat I heard, and a few times I am sure something was trying to come on board the ship. They say an octopus never leaves the water. This one must have been a large one judging from the size of that one arm I saw. Things were getting interesting now. At sunrise the next morning we lifted anchor and away we were again for Aldabra. Plenty of high winds and big high waves all the rest of the way down. No stormy petrels were seen so, as was expected, no storms were encouncountered. One day out from the Aldabras we began to see the Booby birds out catching their small fish for their young back on Aldabra. At times we could see some of those high flying albatrosses. They never seemed to flap their wings.

It was always interesting to me when it came time to "shoot the sun," or maybe it was "shooting Venus," to get our bearings. I would listen to BBC and give the exact time, just a few seconds off and your QTH would be a few miles off course. Remember you don't see these flat islands in this area if you are more than 4 or 5 miles off course. Harvey and Jake both used their own sextants and did their own figuring. Most of the time both came up with the exact same QTH. You try measuring the exact angle of the sun or a star from a tossing and pitching ship. A sextant you know has two images on it, one is the horizon and the other you see the object you are shooting, such as the Star, Moon, Sun etc. You are interested in the EXACT number of degrees this object is above the horizon at a certain exact second. I tried it myself a few times and doggoned near fell overboard. When the ship leans to the left you lean to the right, etc. It still looks impossible to me. You really have to have "sea legs" to keep your body always at a 90 degree angle from the horizon. Harvey's black cat did catch a few flying fish that landed on deck, slipping and sliding all

the way, and Harvey saying "look at that crazy cat." Harvey first spotted the Island, and neither Jake or I could see it. When these islands are just on the horizon, being flat, they are nearly impossible to be seen by an untrained eye. When first seen they are actually part of the horizon but just a little darker in color from the sea. Of course in about one hour both Jake and I could see the island. Out came the maps of the Aldabras and we decided just where we wanted to land, or at least unload my equipment. We pulled up opposite the inhabited part of the island—the island is sort of horseshoe shaped, some 15 or 20 miles from tip to tip. The inhabited portion is near one end, most of the rest has birds as inhabitants, mostly those booby birds we had seen fishing when we neared the island. By the time we arrived at the place we wanted to take my equipment ashore to many of the small pirogues met us from the island. We were the first boat they had seen for a number of months. My letter of introduction was produced and shown the island manager; this letter I brought along with me was from the leasee of the island who lives on the Seychelles. Aldabra is crown property and cannot be bought like most of the other islands, I suppose that's why its considered a new country. We all went ashore, had a very fine lunch, we gave the island manager the mail we had brought along to the islanders from Mahe.

Next month I'll talk about the visit on Aldabra.

Around the U.S.A.

I am writing this episode of my story while in the middle of my trip around the USA and Canada showing my color slides and telling the boys of my experiences on overseas DXpeditions. Peggy is doing the same for the ladies. At this point in our travels we have stopped at Richmond, Va., Washington, DC, the Pittsburgh area, Dayton, Ohio, at their big annual get together, Detroit, Buffalo, N.Y., The big one at Boston and then up to Montreal with the VE2 boys and down to Toronto with the VE3 fellows and on to Philadelphia. Then the Potomac Valley and Frankford Radio Clubs have their annual get-together.

Peggy and I are having a wonderful trip meeting the fellows I have QSO'ed from so many places. Of course all their calls are being placed in my little WHITE BOOK for possible future use. I will be forever obligated to the many friends I have for making this trip around the country possible for Peggy and me. I am about to start putting some antennas up when we return back home on July 4th or 5th. Am taking my old 5 element yagi apart and using the boom for a new U.S. Fiberglass 4 element 3 band quad. I want to see how it will stack up on DX work. At this moment I am not sure just how long I will be at home before another DXpedition gets under way.

With the all new W T W now on, almost any place I go will be a new one for nearly everyone. From the sounds of the bands the little bit I have been able to listen it seems that W T W has begun to catch on very nicely and I think when it gets in full swing things will be popping for some time. With awards for each band and with Phone and CW separated we think we have a good thing. The full W T W Country list is not yet complete. We are still QRX for the countries that a few of the larger national societies have to send us. As a rough estimate it looks as if there will eventually be something over 400 in the W T W list. We have begun with the ARRL DXCC list and adding to it those countries suggested by national societies. We refuse to be asked embarrassing questions as to why such and such a place is on our country list. We will refer all questions to the national society that suggested them to us. That will be the end of any questions asked us. We are letting everyone except ourselves make up the W T W country list.

A few pages of this episode is being written while we stopped by the home QTH on our way from Philadelphia to Little Rock where Peggy and I will be stopping by to visit old Moritz-WA5EFL, for one night, then on to Houston and my old buddy Frank W5IGJ, that gud guy with those fast dots on his bug, and the West Gulf boys. Then continue on West from there, on up to Canada, might be able to operate a little signing /VE8 I hope. Peggy and I sure are seeing the USA and Canada this time. We are driving our little new Mustang that we got from W4YJQ that DXer in Orlando, Florida. It runs like a sewing machine and purrs along in fine shape. We have air conditioner in it so will be prepared for the hot weather we expect before we get back home in July. The gang and I are having many late eye-ball QSO's in the wee hours of the night and I am very pleased to know many of them are getting into our all-new W T W with gusto.

Many of them have expressed their thanks for something really new being started in the way of a good DX award. All QSO's must take place you know after 0001 GMT May 1, 1966, to count towards the W T W.

It certainly is great meeting all my good friends in person all over the country. It's very

good to know that Peggy and I have so many really sincere friends in every state; it makes us both fell very good to have all these fine friends everywhere we go. One of the highlights of our trip so far has been our visit to Peterborough, New Hampshire, and the home of 73 magazine, where we were welcomed by the whole crew there including Wayne and Paul. You know Wayne has a 37 room house there and the entire works for publication of 73 is under just one roof. Looked like only about 9 employees do the whole job. Each person knows what his or her job is and they do it. No rushing around like some places, everyone seemed to be taking it easy, doing their job. I wonder how many people it takes to put out QST or CQ? I would think it's a lot more than 9 people at each place. It seems that the crew at 73 must be very efficient to turn out such a good magazine with so few people. There was a big difference in the temperature in New Hampshire from what is was when we left Orangeburg, South Carolina, a few weeks before. The weather the night we stayed there dropped down to the thirties and the TV weather man said the South Carolina weather that day went up into the 80's. We certainly were treated very fine at 73 magazine and hope some day to return for another visit there. Wayne certainly should be congratulated for the job he is doing there with so few people. All I can say Wayne is "keep up the FB job you are doing in 73 magazine."

Oh yes I got to add two new call signs to my list, by operating as both /VE2 and /VE3, now the total is 119 different call signs for me. Have any of you fellows ever seen a ham station that uses 16 one-hundred-and-thirty-foot towers? Well that's what Clem-WIEVT uses. Did any of you know that Chas-WIFH carries a pistol while working at his package shop—it's located in one of the toughest spots it Boston. Many such interesting things were found out about different people here and there along our route. A new president was needed by ARRL and there was a lot of talk in the many hotel rooms as to who the new president would be. By the time this is in print this will be old news. It was interesting to see and hear this being discussed by so many people. Probably the new man was chosen that Saturday night in Boston in the various hotel rooms. High politics are quite interesting to watch and hear discussed. As usual I drank many Coco Colas at this convention and other places along the way. Of course many other drinks were drunk by others, some quite a bit stronger than Cokes, too!

. . . Gus

Protect Your VTVM!

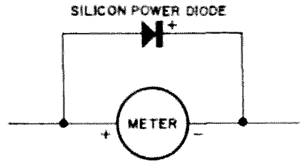


Fig. 1. Using the forward voltage knee of a silicon diode to protect a sensitive meter movement.

Since the rise of the Zener diode, meter-protection circuits using such a semiconductor across the meter movement to short everything out in the case of too much voltage have been flooding the literature.

Not so well known, however, is the fact that an ordinary silicon power rectifier has a "Zener break" in its forward characteristic at approximately one-half volt which can be put to similar use.

It's especially adaptable to protection of VTVM meter movements, which typically use 200 microamp ratings. Though they are advertised as "burnout-proof," which they are, these meters can still be damaged by severe over-voltage which slams the needle against the stop so hard that the needle bends.

But an ordinary silicon diode parallelled across the meter as shown in **Fig. 1** prevents such damage. During normal operation, the diode is effectively an open circuit since voltage across the meter coil doesn't rise above 0.2 volts, while the diode won't conduct below 0.5 volts. But with over-voltage applied, the diode goes into conduction at half a volt and shorts out the meter. This prevents the needle-bending slam across the scale, yet the half-volt present across the coil will shove the needle far enough offscale to tell you something's wrong.

In one VTVM circuit with which the idea was tested, the meter survived a 30-time over-voltage with no trace of damage. Coil current was limited to 250 microamps by the diode, which is only a 20-percent overload. With the scale of the VTVM set for 0-3 VDC, this corresponds to a 90-volt input. Try it with an unprotected meter (if you've got plenty of money to replace movements) and see what happens!

. . . Jim Kyle K5JKX

Resistors

We do not usually think of the lowly resistor as having any special characteristics to give it personality. I am sure most of you will be surprised, as I was, to find that the common carbon resistor is more than just a resistor. Did you know that it has inductance and capacitance so that it has a self resonance frequency?

The capacitance between the granules of a composition resistor tends to cause the reactance and resistance to drop with frequency. The skin effect tends to increase the reactance with frequency.

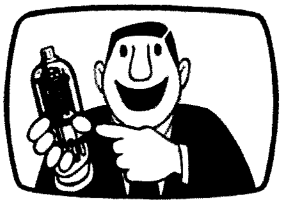
Resistor manufacturers are constantly striving to make better resistors. The best high frequency characteristic in a fixed composition resistor is achieved when the ratio of cross-sectional area to the length of the resistor is minimized. Small cross-section and fewer carbon binder contacts improve the high frequency characteristics. A standard ½ watt 1 megohm resistor will drop to only 10 percent of its DC resistance at a frequency of 500 MHz. A 1000 ohm ½ watter will hold 100 percent to 50 Mhz and drop to 85 percent at 500 MHz.

Various methods are used to get rid of the heat, and this is important because the resistance value will change with heat. The change is not too great (maybe 4 percent) but if it gets too hot it will not return to its original value. In operation, most of the heat (60 percent) is removed by conduction through the leads and 35 percent by convection to the surrounding air and the balance by radiation. It is not a bad idea to try to keep the heat down when soldering resistors because of the possible change. Use long leads if possible. The little clips used for soldering diodes and transistors will help.

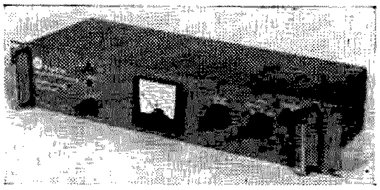
Wire-wound resistors have always been considered as having inductance unless they are specials. The newer low wattage units look like composition, but you can tell them apart because the first color band is extra wide. These resistors can be used as low Q chokes if you can tolerate the resistance. Some typical values for a ½ watt and a 2 watt wire-wound would be as shown in the table below:

Resistance Ohms	Inductance ½ Watt/μH	Inductance 2 Watt/μH
0.5	0.04	0.12
1.0	0.04	0.09
5.0	0.10	0.18
10.0	0.09	0.24
100.0	0.75	0.80
1000.0	1.50	3.40

Ralph Hanna W8QUR

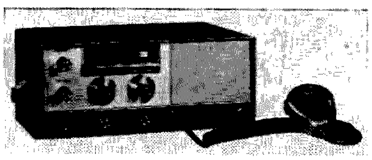


NEW PRODUCTS



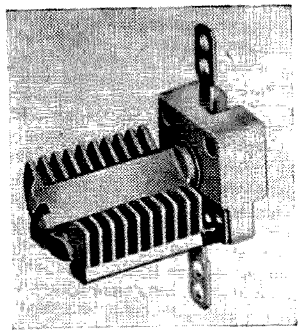
Tuck Model 103 High Frequency Exciter

Tuck Electronics has just announced a new series of solid-state high-frequency exciters that provide 2 watts output over a frequency range from below 1 MHz to above 30 MHz without tuning. Although the Model 103 illustrated above has a two position crystal oscillator, other models are available with up to ten crystal positions. For the RTTY enthusiasts a special crystal oscillator is available with provisions for frequency shift. Complete details on this unit and the entire Tuck line is available from Tuck Electronics, 2331 Chestnut Street, Camp Hill, Pennsylvania 17011.



Lafayette 6 and 10 Meter Transceivers

Lafayette has just introduced a new line of transceivers for 6 and 10 meter operation that should prove popular with amateurs both young and old. These new transceivers feature a dual conversion receiver with a sensitive Nuvistor rf amplifier, crystal controlled second converter and an SCR controlled noise limiter that provides high sensitivity *without* harsh noise. The transmitter runs a full 20 watts input and has a built-in VFO, low pass filter, and both AC and DC power supplies. In addition, a push-to-talk ceramic mike and mobile mounting bracket are included in the package. Although a VFO comes with the transmitter, provision is made for crystal control with standard 8 MHz crystals. The Model HA-460 covers 50 to 52 MHz and the Model 410, 28.0 to 29.7 MHz. Price: $149.95. For more information, write to Lafayette Radio, 111 Jericho Turnpike, Syosset, L.I., New York.



Johnson Capacitors

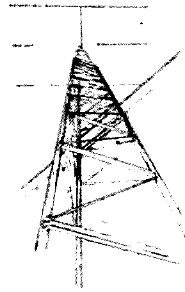
With the new Type "U" high-density capacitor, Johnson has expanded its air variable capacitor line to include more than eleven basic types in a wide selection of single- and dual-section, butterfly and differential units. Models in the line range from miniscule subminiature types to large, heavy-duty units rated up to 1700 pF and 13,000 volts peak. The unique design of capacitors machined from solid brass bar stock provides wide tuning range, uniformity and stability that is ideally suited to all types of tuning and trimmer applications. The larger plate area of the new Type "U" capacitor provides a 28 per cent increase in capacitance with no increase in size. These units require less than 0.2 spare inches for mounting and exhibit "Q" greater than 1500 at 1 MHz. Complete details on these capacitors and other components in the Johnson line are provided in the company's new 36-page Catalog No. 700. Write to E. F. Johnson Company, Waseca. Minnesota.

Ekiind Allen Wrenches

The Elkind Tool and Manufacturing Company has come up with a set of T-Handled hex keys that you can really get a good grip on. These new wrenches come in three lengths, 3, 6 and 9 inches, and in eleven sizes from 5/64 to 3/8 inch. Eklind Tool and Manufacturing Co., 2627 N. Western Avenue, Chicago, Illinois 60647.

E-Z Mobile Antenna Mount

The new E-Z Mobile Antenna Mount provides a neat way of attaching your antenna to your mobile without drilling any holes. This new mount attaches to your trunk lid in minutes and in many cases provides increased radiation efficiency because the trunk deck exhibits a superior ground plane. These mounts are available over the conventional bumper mount with various antenna mounting holes including 3/8", 1/4", and small or medium ball. $8.95 from your local dealer or write to E-Z Mobile Antenna Mount Inc., P.O. Box 277, Algonac, Michigan.



Tristao CZ-454 Crank-up Tower

The Tristao Tower Company has just announced a new crank-up tower that is especially suited for the ham with a *problem* installation; the operator who wants his antenna 60 feet in the air but has little or no room for guys. The new Tristao CZ-454 tower is attached to a building 10 or 15 feet above the ground and has sufficient stiffness to support an average tri-bander beam when fully cranked up. The diagonal steel bracing and heavy channel step bracing provide the strength to withstand strong winds even with a tri-bander on top. The new geared winch features an automatic locking disc brake. This brake provides constant safety in both the lowering and raising positions because whenever the handle is released the brake locks the winch. In addition it may be padlocked to prevent unauthorized use. These towers are hot dip galvanized after fabrication for maximum durability and a hinged base, house mounting bracket and rotator mounting plate are included with each tower. $349.95 from your local distributor or write to Tristao Tower Company, 415 East Fifth Street, P.O. Box 115, Hanford, California 93231.

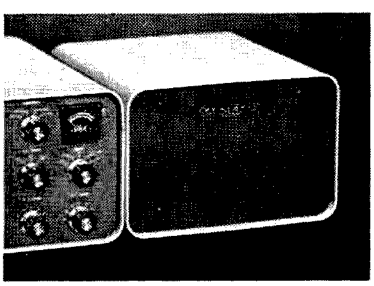
Amperex 8643 Twin Tetrode

Amperex has just announced the new 8643 mobile power tube which incorporates a new type of cathode which is relatively immune to variations in battery supply voltages. With this new design, the cathode can deliver 90% of the rate power without damage even though the supply voltage varies from as much as 16 volts or as little as 10 volts. Actually the 8643 is the first in a family of Amperex twin tetrodes that feature this new cathode design. It is indirectly heated tube, designed for use as an RF power amplifier, oscillator or frequency multiplier up to 175 MHz. Under ICAS conditions it will produce 123 watts with 3.5 watts drive. For more information write to Amperex Electronic Corporation, Tube Division, Hicksville, Long Island, New York 11802.

Field Effect Transistors from Motorola

Two new lines of N-channel field effect transistors for rf and audio work have been introduced by Motorola Semiconductor Products Inc. The main feature of these new FET's is their relative low cost. The audio and general purpose 2N4220-22 are priced at \$2.85 in small quantities and the rf types 2N4223-24 as low as \$3.65; compare this with the 1965 average of \$7.00 for all FET's. In applications such as tone control for hi-fi audio amplifiers, the high input impedance of the 2N4220 series allows for vacuum tube design principles in the selection of tone control elements. As a result, high resistance values and small, low-cost, more reliable capacitors may be used. In addition, the low noise of these transistors provides a definite advantage over conventional transistors.

For applications in low-noise rf amplifiers, the 2N4223-24 types offer low cross-modulation and intermodulation distortion, a maximum noise figure of 5 dB at 200 MHz, plus a minimum gain of 10 dB at 200 MHz. Consequently it is now possible to construct rf amplifier circuits with the assurance of minimum distortion and low noise, as well as good gain with the advantages of small size. These new devices are available from any Motorola Franchised Distributor or District Office. For more complete information write the Technical Information Center, Motorola Semiconductor Products, Inc., Box 955, Phoenix, Arizona 85001.

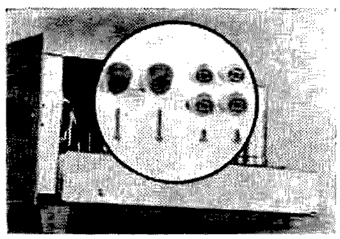


Heath SB-600 Communications Speaker

The Heathkit SB-600 Communications Speaker features styling to match the Heath SB-Series line of amateur equipment and matches the 8 ohm audio output from the SB-100, SB-110 and SB-300. This new speaker had an audio response from 300 to 3000 Hz and it is especially well suited for single sideband communications where the audio pass band is relatively narrow. The interior of this unit is quite large and includes space for mounting the fixed-station HP-23 power supply, which is used with the SB-100 and SB-110. \$17.95 from the Heath Company, Benton Harbor, Michigan 49022.

Heath HD-15 Hybrid Phone Patch

The new Heath HD-15 Hybrid Phone Patch provides swift, efficient coupling of your equipment to the phone lines. It includes complete facilities for the monitoring and control of transmitted and received signals with separate controls for receiver-to-line and line-to-transmitter audio levels and a panel-mounted VU meter. This new patch matches 3-16 ohm speaker circuit and high impedance transmitter input circuits to the 600 ohm telephone lines. The hybrid circuitry permits use with VOX controlled equipment as well as push-to-talk operated transmitter. The HD-15 features low-silhouette styling and color scheme to match the Heath SB-Series equipment. $24.95. For complete specifications write to Heath Company, Benton Harbor, Michigan 49022.



Budwig Cabinet Mounts

The new Budwig cabinet mounting feet and extenders make it simple to create convenient tilted-front panels. Each 89¢ kit includes four soft plastic feet, two rigid polypropylene extenders and the mounting screws. Details are available from the Budwig Manufacturing Company, P.O. Box 97, Ramona, California 92065.

General Electric Hobby Kit

The article on Vectorboards in the issue of 73 probably has a lot of you anxious to try them out. Unfortunately, many radio distributors around the country don't carry them in stock. But GE is now selling a small kit of a punched board, a number of terminals, and even feet for the board for only 98¢ at their many distributors. It's made for the projects in their new Hobby Manual, but the kit is also ideal for other small circuits. Look for the kit at the GE hobby display at your local wholesaler.

DENSON ELECTRONICS CORPORATION

MILITARY TEST SETS — MILITARY COMMUNICATIONS

TEST EQUIPMENT

29,023—APA/6A/ID46 Ind.	U	89.50
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29,328—APQ-5	U	49.50
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19,471—CV-253/ALR tuning unit for APR/4 receivers. Late model high sensitivity unit covering 38-1000 mc in 4 bands	LN	195.00
29,414—APQ2-Radar jammer less B+ power supply		29.95
19,472—APR4Y—receiver w/matching 115VAC to 400 cycles pwr/supply. Late model w/variable selectivity & AM-FM capability. Less tuning units	LN	295.00
19,454—APR-4 Receiver	G	145.00
19,455—TN-16/APR-4 38-95MC		50.00
19,456—TN-17 74-320 Mc	G	55.00
19,457—TN 18 300-1000 Mc	G	60.00
19,458—TN-19 975-2200 Mc	G	125.00
19,459—TN 54 2150-4000 Mc	G	195.00
19,393—APT-5/T-85 conv.—no cabinet	U	49.50
19,389—ARC-3/T-67 w/tubes	LN	34.50
19,283—ARC-3/R77	LN	34.50
19,390—ARC-3/R77A l/tubes	U	24.50
19,390—ARC-3/R77A w/tubes	LN	34.50
19,461—ARC5/R-26 Rec. 3-6 mc	LN	19.50
19,462—ARC5/R27 Rec. 6-9.1	LN	19.50
19,391—ARN/5A-R89 less tubes	U	5.95
19,266—ARN7/R5 Rec. 100-1750 KC	U	24.50
19,285—ARR-2R4 less tubes	P	5.00
VIDEO TRANSMITTERS		
19,152—ART-26 less tubes & meter	U	59.00
19,153—ART-26 w/tubes & meter	U	99.00
19,154—ART-26 Brand new		129.50
796—ART-26 Conv. Inst. & Sch.		1.50
19,155—ART-28 High Pwr. Video Transmitter (400 W Peak Sync) with 28VDC Pwr.	N	279.00
797—ART-28 Photo copy of Sch. w/parts values		15.00
29,020—ASB-5/ACB Ind.	LN	19.50
19,124—ATK/CRV 59AAD camera w/transmitter—no pwr. supp., tubes or lens. Useable parts only		35.00

"BLOCK" ATJ/ATK RCA SYSTEM		
19,126—ATJ Camera w/tubes & lens	LN	100.00
19,121—ATJ Conv. w/pwr. supply for 115 VAC	U	100.00
19,120—ATJ Converted	U	130.00
19,127—Lens & mount for ATJ	U	20.00
19,125—ATJ less tubes & lens	P	35.00
794—Conv. data for ATJ/ATK Cameras w/sch.		5.00
19,128—AXT-2A Camera w/2P 21 I.O. or 5820 tube high sens.	U	295.00
792—Conv. data & sch. w/parts values for AXT-2A		5.00
19,150—AXT-2 Transmitter	LN	25.00
785—Conv. data w/sch. & parts values for AXT-2 Trans.		5.00
19,129—ATJ/60ABK Monitor	LN	25.00
765—Conv. Surplus Video Monitors Sch. w/parts values		.50
19,130—Dynamotor for "Block"	U	50.00
19,131—"Block" Junction Box	G	12.50
19,132—Compl. "Block" system comprising ATJ camera, monitor ATJ, dynamotor, lens, transmitter, receiver, junction box w/necessary cables & plugs plus instr. Close Out Special		295.00
772—Junction Box, Cables & Dyna motor wiring assy. sch.		1.00
29,019—Ind. model ID 66/AXR-1 (N130-S-28439)	U	24.50
29,021—AXR-1/ID-66 partly conv. w/AC pwr.—no tubes incl. 7CP 1	F	24.50
19,136—CRV-46ACD Rec. chann. 1-10	U	139.50
19,135—Block Rec. for Military channels 1-5	U	79.50
799—Sch. for either #19,136 or #19,135 (specify)		5.00
19,141—AXT-6/1 Camera w/type 212 Vericon	N	279.50
19,143—AXT-6/2 Sync unit	N	150.00
19,142—AXT-6/3 Camera w/type LM15 I.O. Pick-up tube	N	295.00
19,151—AXT-6/5 Transm.	N	250.00
19,144—AXT-7 Camera w/2P 22 orth. pick-up tube less case	U	395.00
19,145—AXT-7 w/2P 22 I.O. tube, enc. in Water-tight case	U	495.00

Write For Free New Anniversary Catalog 966A-1

IMPORTANT: To save space, the following items have been coded as to condition:
N—New
LN—Like new means appearance, cond. etc. but may be dusty.
U—Used in gen. is good cond. & usable without repairs.
F—Fair, in reasonably good cond. but minor repairs may be required.
P—Poor, these items will require major repairs to make operational & should be considered more a source of spare parts rather than useable.

All items are offered subject to prior sale; all prices are subject to change without notice. The prices listed are NET-FOB, Rockville, Conn.

DENSON ELECTRONICS CORPORATION

P.O. Box 85 Rockville, Connecticut
Phone 203-875-5198

New Books

RCA Transistor Manual

The new RCA Transistor Manual, the SC-12, has been expanded by more than 20 per cent from previous editions. This new 480 page manual covers many new semiconductor devices and applications, a *streamlined* data section with more extensive data on active transistors, up-to-date transistor selection charts, and information on mounting hardware, mil-spec transistors and circuits. In addition, the SC-12 contains 145 pages of text which has been written to bring the reader up to date on the latest semiconductor technology and applications. Included is a completely new chapter on MOS field effect transistors, as well as information on transistor frequency converters, rf power amplifiers, detection circuits, power switching circuits and TV sync and deflection circuits. The circuits section has been revised to include more than 40 transistor circuits, complete with parts lists. Copies of this new manual may be obtained from RCA Distributors or by sending $1.50 to Commercial Engineering, RCA Electronic Components and Devices, Harrison, New Jersey 07029.

Electronic Construction Techniques

This book is just what the doctor ordered for the ham who builds his own gear. George L. Ritchie, the author, has had many years of experience teaching electronics construction at San Jose City College in California, so he is well qualified to point out many of the subtleties of building electronics equipment. This book is not just a wiring and soldering manual, but includes details on electronics drafting, bending and forming all types of chassis, making printed circuit boards, mounting components and using all types of tools, including the lathe. If you have ever tried to make up your own chassis and didn't know exactly where to start, this book will tell you; and after the chassis is made, you can find complete details on how to finish it whether it be paint, anodize or alodine. Although most of the author's construction techniques are based on the use of metal brakes, shears and punches, with a little ingenuity the average ham can duplicate any of these procedures with a pair of aviation snips and a couple of hardwood boards clamped in a bench vise. $4.95 from your local bookstore or through the publisher, Holt, Rinehart and Winston, Inc., 383 Madison Avenue, New York, New York 10017.

Basic Electricity for Electronics

Like the old adage says, "The hardest thing about ham radio is getting started." However, this new book by Robert Middleton and Milton Goldstein removes some of the pain of getting started. Although not written exclusively with the radio amateur in mind, it covers electronics in a thoroughly enlightening and interesting manner that should appeal to novices and beginners. There is almost no math in the text and the authors have provided lots of illustrations, so many of the important points are immediately brought home. One advantage this new 694 page volume has over previous books of the same nature is its coverage of semiconductors and transistors; however, vacuum tubes are not completely forgotten and there is a chapter on them too. By in large though, the main body of the book is devoted to the more basic aspects of electronics, including dc and ac circuits, transformers and tuned circuits. In addition, the appendix in the back of the book is chock full of useful electronic data. $9.95 from your bookstore or write to the publisher, Holt, Rinehart and Winston, Inc., 383 Madison Avenue, New York, New York 10017

Transistor Circuit Analysis and Design

Here is an easy-to-use reference for amateurs and technicians interested in transistor circuitry. Except for the first chapters of the book which discuss basic semiconductor physics, this book is completely practical in nature and John J. Corning, the author, presents an easy-to-read approach to all types of transistor circuit design. Unlike many books which were written with only the professional design engineer in mind, all you need is a knowledge of algebra and basic electrical circuits to successfully use this book. The author discusses dc bias techniques at great length, and then thoroughly covers low frequency (audio) amplifiers, large signal amplifiers, high-frequency amplifiers, oscillators, pulse circuits and power supplies. In each of these discussions, the operation of each of the circuits is completely analyzed and complete details are provided. In addition, the effect of different component values, particularly bypass and coupling capacitors, is described in detail. All in all, this book is a very complete manual of transistor circuit design that should appeal to anyone interested in designing their own transistor circuits. Available from your local bookstore or write to the publisher, Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

Motorola Semiconductor Handbook

Motorola's new 216-page Silicon Rectifier Handbook provides all the information required in the intelligent selection and application of silicon rectifiers. This new handbook is particularly valuable because all phases of the rectifier art are completely covered; all types of rectifier circuits as well as voltage multipliers and regulation circuits, arc suppression and other specialized circuits are described and analyzed. It is available for $1.50 from your local Motorola Semiconductor distributor or from the Technical Information Center, Box 955, Phoenix, Arizona 85001.

First-Class Radiotelephone License Handbook

Since the FCC has revised its requirements for the First-Class Phone license to include a thorough understanding of semiconductors and their circuit applications, a new license manual which covers these facets of electronics has been sorely needed. Edward M. Noll's First-Class Radiotelephone License Handbook not only fills this need, but also explains the practical skills and know-how the technician or amateur must have as a qualified broadcast technician or engineer. Although this book contains a comprehensive question-and-answer section, it is far more than an exam preparation manual and includes chapters on all phases of radio communications. Copies are available for $4.95 from your electronics parts distributor or from the publisher, Howard W. Sams & Co., Inc., 4300 West 62nd Street, Indianapolis, Indiana 46206.

Allied Electronics Data Handbook

The fifth edition of Allied's popular Electronics Data Handbook has been revised and enlarged to include new and up-dated material for use in electronics. This handy little reference book has sections on electronics math, radio and electronic formulas, transmission lines, vacuum tubes, transistors and 70-volt speaker matching systems. Included are attenuator networks, coil winding formulas, wire table, charts for inductance, capacitance and resistance, metric conversions, logarithms, trigonometric functions, and much more. All of the material in the handbook was compiled with the cooperation of technical specialists on the staffs of electronics manufacturers and publishing houses, so it contains just about all the reference material ever needed in the ham workshop. This new handbook is available for 75 cents from Allied Radio Corp., 100 N. Western, Chicago, Illinois 60680.

go in for fairly sophisticated research that seems to be uncommon in the small ham radio field. So they fall back on the old dodge that if it costs twice as much, it must be twice as good.

Why don't we double our rates? Because the advertisers would realize that we weren't delivering twice the value to them. But on the other hand, one of our competitors with falling circulation (both competitors are in this category, so I'm not telling tales) raised its rates a considerable amount last year! Of course, their advertising is down, but we can't be positive that there is a direct relationship because of other factors.

We don't get the big mail order dealers with their fat catalogs because they get poor returns on the coupons they insert in 73. The reason was plain after we evaluated a poll we took a year or so ago: most 73 readers are active hams. They already have most of the catalogs. But many readers of some other electronics magazines are not active, or serious about their hobby. They don't have many catalogs, so often request them. And nothing is more difficult than convincing some advertising managers that they'd be better off selling merchandise than free catalogs!

Advertising is a fascinating subject. Editors aren't supposed to concern themselves with advertising, but this is a small magazine. We can see the results of ads very quickly. More ads mean more pages, more articles. If any of you are considering advertising in a ham magazine, I would suggest that you write or call WØRA for more information. We also have a small booklet on the mechanics of inserting ads in 73. You might like a copy if you're serious about getting into national advertising.

Well informed hams

The June 13, 1966, issue of Newsweek gave ham radio a nice plug:

People-to-People Radio

> An elaborate study by the Pentagon's Advanced Research Projects Agency has singled out what may be the best-informed group of citizens in the Soviet Union: the 15,000 to 20,000 Russian radio hams. Besides tuning in on the Voice of America and the BBC, the hams converse with short-wave operators around the world. The ARPA study was designed to learn how best to communicate with people in closed societies.

Current events

Letters wondering what happened to the semiconductor column I wrote last year suggest that there's a need for a monthly column devoted to all sorts of new technical developments. Among the things it might discuss are new transistors, hints on antennas, new surplus, frequencies for technical nets, questions and comments about 73 articles, addresses of technical clubs and so forth. Why not send in items of this type that you think might interest other technically-minded hams.

2300 MHz moonbounce?

With 144, 432 and 1296 under their belts, moonbouncers are zeroing in on the next higher ham band, 13 cm (2300 to 2450 MHz). This band has some advantage for moonbounce over lower bands, but also has two prominent disadvantages: the difficulty of generating high power and high noise figure in receivers. Neither seems to be insurmountable, though. High power klystrons are "available" for serious UHF'ers and a paramp for 2300 apparently isn't that much worse than one for 1300. A universal frequency like 432 or 1296 hasn't been accepted yet, but 2304 MHz (the 16th harmonic of 144) has been suggested. We'd like to hear from you 2300 boys so everyone will know what you're up to.

Insert booklets

This month we're running the second of our booklet-length feature articles. It's the middle of a three part series by WA6BSO on coax systems. Next month's booklet will be devoted to coax accessories such as switches, relays, baluns, SWR bridges, and dummy loads. A number of other booklets are in the planning stages. If you have any suggestions for 16 to 48 page booklets, or are interested in writing one, please get in touch.

We originally planned to have the books bound separately and inserted in the magazine so that they could be removed easily, but the post office foiled that. They have some very peculiar regulations.

Writing for 73

Authors and prospective authors are invited to send a self-addressed stamped 10¢ business envelope for our new booklet "Writing for 73." I think you'll find it useful.

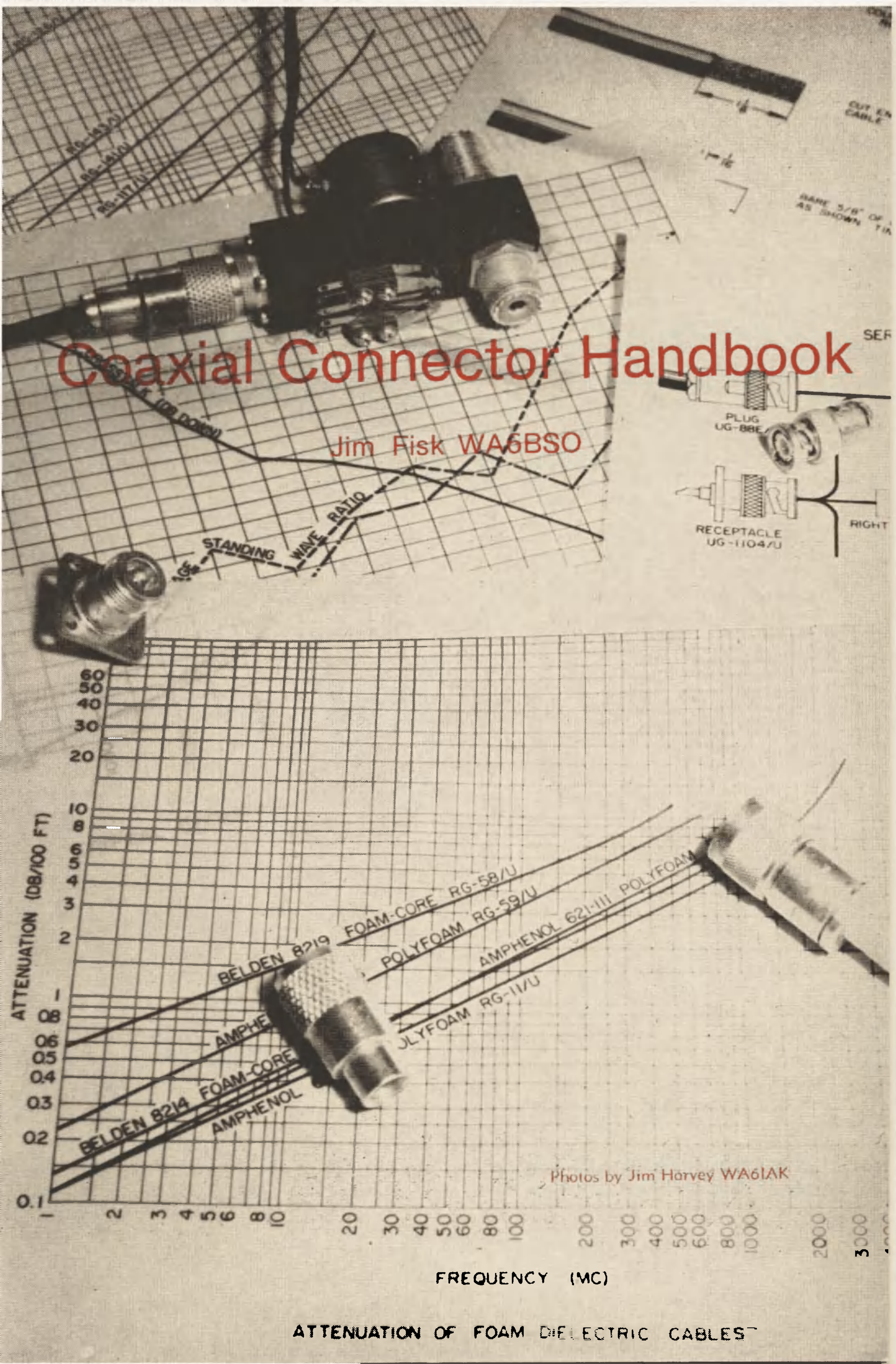
Note for editors

A recent issue of *Better Editing* includes an article with a provocative title: "If You Go Riding off on a White Horse, Don't Forget Your Tin Pants."

. . . Paul

Coaxial Connector Handbook

Jim Fisk WA6BSO



Photos by Jim Harvey WA6IAK

Coaxial Connector Handbook

At the lowest audio frequencies and dc, coaxial cable connections consisting of simple solder joints to both conductors are sufficient in many cases. However, as the frequency of operation is increased into the low megacycle range, such connections allow leakage of rf energy and it is necessary to provide 360° contact with the outer conductor to completely contain the conducted electromagnetic field within the confines of the cable. At these frequencies the characteristic impedance of the section of line represented by the inner and outer diameters of the connector is generally not too important; the familiar series UHF connectors or "phono" connectors are illustrative of connectors suitable for these frequencies.

As the frequency of operation is increased beyond 150 mc, it becomes increasingly important that the characteristic impedance of the connector be the same as that of the cable. Also, any physical discontinuities such as the pin diameter of the connector differing from the cable inner conductor diameter must be held to a minimum. Common physical discontinuities such as steps or radial grooves in conductors act like shunt capacitors or series inductors respectively.

The adverse effect of these reactive components increases with frequency; therefore, to maintain a given standard of performance, the physical size of the discontinuities must be effectively made smaller and smaller as frequency is increased. Unfortunately it is not always possible to avoid all discontinuities and at the same time maintain a strong mechanical joint. In those cases where it is impossible to avoid discontinuities in the connector, they are compensated for by deliberately placing another compensating discontinuity in the same vicinity.

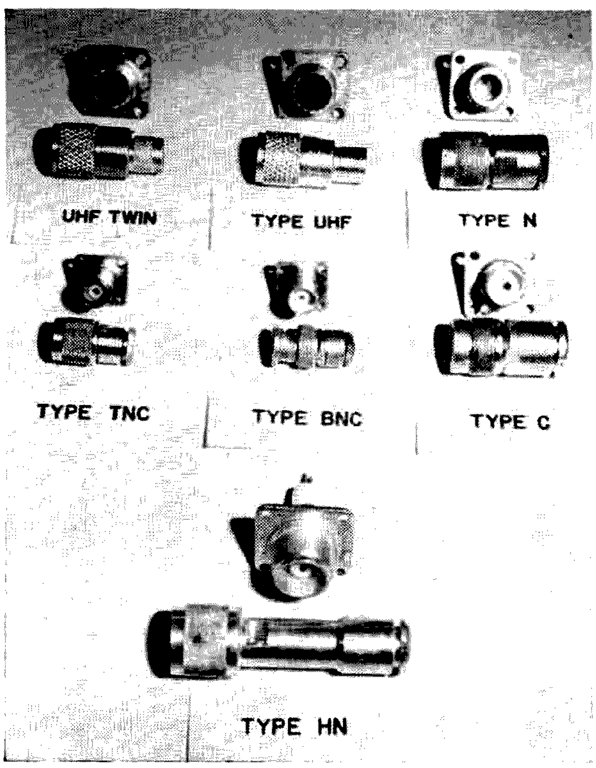
Types of coaxial connectors

Standardization of coaxial connectors has immeasurably aided in the selection and use of these devices. A direct result of this standardization is that a connector made by one manufacturer is directly interchangeable with similar connectors made by any other company.

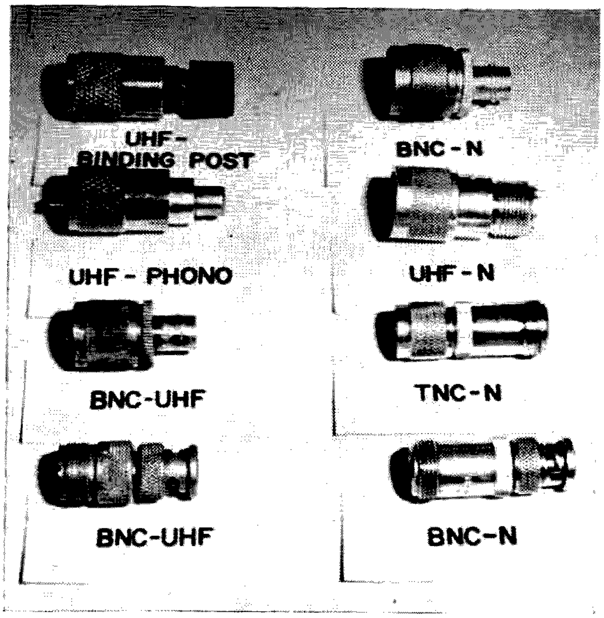
Coaxial connectors may be categorized by the method of coupling and cable size with which they may be used as shown in **Table 1.** Essentially, there are three methods of coupling; threaded, bayonet, and push-on. The five major cable sizes are subminiature, small, medium, medium-large and large. Although the various coaxial connectors were designed specifically for the cable sizes shown in **Table 1**, some types may be used with other cables. The Type N for instance, is available in configurations that are suitable for small, medium, medium-large and large coaxial lines.

Most major types of connectors are available in several different configurations within the series, based upon contact arrangement and cable clamping mechanisms. The three main divisions are "standard," "improved," and "captivated contact."

The "standard" connector employs a sleeve type or grooved silicone gasket which allows metal-to-metal braid clamping. The "improved" type used a "V" groove silicone rubber gasket which also provides metal-to-metal clamping but provides a better grip on the cable with minimum braid deformation and better SWR. In most cases the improved connectors may be used at considerably higher



Various coaxial connectors.



Straight between-series adapters.

frequencies than the standard versions. For example, standard Type N connectors have an upper frequency limit of 3500 mc whereas the improved version may be used to 10,000 mc.

"Captivated contact" connectors were designed to keep the center contact in a fixed position within the connector. This type is recommended for cables using Teflon dielectric and Teflon or fiberglass jackets. These cables, although excellent for high temperature applications, are difficult to use because the inner conductor has a tendency to shift when subjected to rapid environmental changes or mechanical stresses. The technique for captivating the contact provides protection against undesirable equipment disconnections.

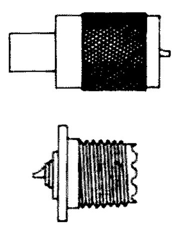
Connectors are also available with clamping devices for subminiature cables and semi-flexible cables such as Phelps Dodge Foamflex. Coaxial connectors are attached to these cables through the use of barbed collets or clamps within the connector. The barbs may be machined into the clamp or a helically grooved sleeve is screwed over a barbed, helically coiled wire wound around the cable. The barbs are embedded in the cable's outer conductor and provide a rigid base for mounting the desired connector.

In addition to these variations, many manufacturers have "polarized" connectors available for the more popular types. These connectors are used to prevent careless or improper connections. The polarization is accomplished by reversing the normal insulation and inner contact assemblies. These connectors will not mate with normal connectors and the selected mating connector must also be polarized.

Two other types of connector construction that are worthy of mention are the crimped and wedged clamping types. The crimped connectors require no soldering and assembly time is reduced as much as 60%. These connectors are often used in large production facilities, and are the least expensive and simplest to assemble of all the connectors that require special tools. Unfortunately, the tools required are quite expensive and the crimped connectors are economical only where large quantities are involved.

One type of wedged clamping connector available is Automatic Metal Products "Wedge-eze" illustrated in **Fig. 1.** This connector is economical, simple to assemble and does not require special tools for assembly. Another advantage over standard crimp types is that these connectors may be reused whereas the crimp styles are usable only once. In the Wedge-eze connector, the wedge-body assembly is placed over the cable dielectric, forcing the braid and outer jacket up over the conical section of the body. The nylon wedge cap then effectively clamps the braid and jacket to the connector as it is screwed on.

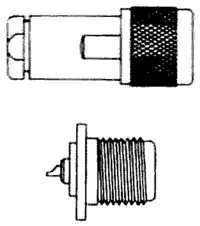
Types of connectors



SERIES UHF

UHF The UHF series was originally designed for use with medium sized cables such as RG-8/U, but reducing adapters were later introduced to permit usage with smaller cables. These non-constant impedance, non-weatherproof connectors are generally satisfactory for use up to about 200 mc and in some specific non-critical cases up to 500 mc. They may be used at peak voltages up to 500 volts. These connectors are made in two sizes, UHF small which is ⅝ inch in diameter and UHF large, one inch in diameter. Plugs, receptacles and adapters were included in the original design, but jacks were not in demand and were not developed. This series also includes twin contact connectors (both large and small) for use with twin coaxial cables such as RG-22/U.

Although this series is the most common coaxial connector found in amateur equipment, it is no longer approved for use on any new equipment built for the Armed Services. The complete family of UHF (single contact) connectors is illustrated in **Fig. 2.**

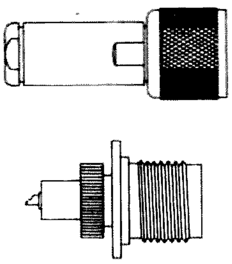


SERIES N

SERIES N Series N connectors are recommended where a medium size, weatherproof connector with a screw type coupling is desired and it is one of the most widely used series of connectors. They are general purpose connectors with constant impedance characteristics and may be used in 50 ohm circuits employing medium sized cables such as RG-8/U. However, when matching requirements are not critical, they may also be used with larger or smaller cables.

The original Series N design used a polystyrene bead as the dielectric material and the connectors were widely used because they were made in 50 ohm, 70 ohm, weatherproof and non-weatherproof varieties. The 50 ohm connectors will not mate with the 70 ohm connectors; however, 50 ohm connectors may be used with 70 ohm coaxial cables where impedance matching is not important. These connectors have a maximum voltage rating of 1500 volts and a practical upper frequency limit of 10,000 mc. They are gasketed for weatherproof operation and are available with various types of metal-to-metal clamping devices.

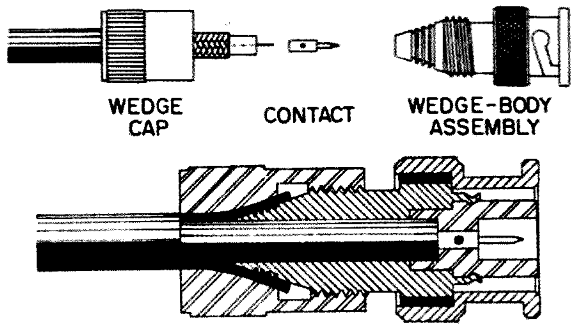
The complete family of type N connectors is shown in **Fig. 3.** This drawing rather graphically illustrates the versatility of this series with the many configurations available.



SERIES HN

SERIES HN Series HN connectors are medium-large weatherproof connectors for the same size cable as series N. The difference being that the dielectric material is tapered to permit their use at higher voltages. The latest version of these connectors employs a step design in lieu of tapering the cable dielectric. These connectors have a nominal impedance of 50 ohms, screw-type coupling and metal-to-metal braid clamping in standard, improved and captivated contact types.

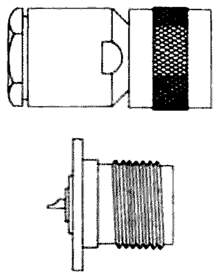
Series HN connectors were originally designed for use in high voltage applications up to 5000 volts peak; however, results of tests conducted by the U. S. Navy indicate that at rf frequencies, the voltage characteristics of the HN connectors are no better than those



ASSEMBLED UNIT

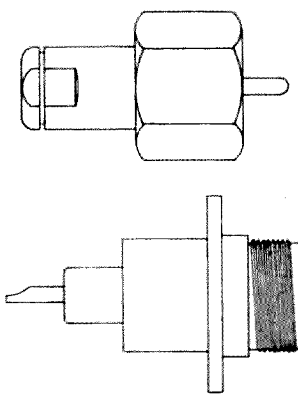
Fig. 1. Typical Wedge-eze construction.

of the C or N series. Consequently, HN connectors should be used for replacement purposes only.



SERIES LN

SERIES LN The series LN connectors are essentially nothing more than an oversized "N" connector originally used with the larger rf cables such as RG-14, -74, and -94/U. These weatherproof connectors have a nominal impedance of 50 ohms and an approximate peak voltage rating of 1000 volts. This series has been replaced by two plugs, UG-204A/U in the N series and UG-494/U in the HN series. Consequently, very few LN connectors are found in present day equipment.



SERIES LC-LT

SERIES LC-LT LC connectors are large-size weatherproof, 50 ohm connectors for RG-17, -18, -19 or -20/U coaxial cables employing screw-type coupling. They are intended for high power rf transmission up to 1000 mc. A jack was not originally designed for this series and it wasn't until the early 1950's that one was introduced.

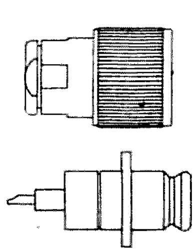
Two groups of LC connectors are available; group LC-1 which will withstand peak voltages of 500 volts and the slightly larger LC-2 which will withstand voltages in excess of 10,000 volts. Where it is desired to operate

		THREADED COUPLING			BAYONET COUPLING				PUSH-ON COUPLING			
Cable Size	Type	Thread	Impedance (ohms)	Max Freq (mc)	Type	Coupling	Impedance (ohms)	Max Freq (mc)	Type	Coupling	Impedance (ohms)	Max Freq (mc)
Subminiature	SM	1/4 X 32	50	1000	TPS	3 prong	50	10000				
Small	BN	3/8 X 32	50	200	BNC	2 prong	50	10000	Phono	Not Detented	Not Matched	200
	TNC	7/16 X 28	50	10000	MHV	3 prong	50	50				
	SKL	3/8 X 32	50	—								
Medium	N	5/8 X 24	50	10000	C	2 prong	50	10000	QDS	Ball Detent	50	10000
	UHF (Single)	5/8 X 24	Not Matched	200								
	UHF (Twin)	5/8 X 24	Not Matched	200								
	SC	11/16 X 24	50	10000								
Medium-Large	UHF (Single)	1 X 20	Not Matched	200								
	UHF (Twin)	1 X 20	Not Matched	200								
	LN	3/4 X 27	50	1000								
	HN	3/4 X 20	50	3500								
Large	LC-1	1 1/4 X 18	50	1000					QDL	Ball Detent	50	1000
	LC-2	1 3/4 X 16	50	1000								
	LT	1 1/4 X 18	50	2500								

Table 1. Coaxial connectors charted by cable size and coupling method.

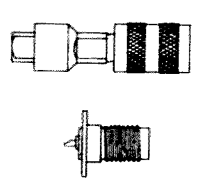
the LC series as a low voltage connector, the cable dielectric is butted flush against the dielectric in the mating connector. For high voltage applications, a counterboring operation is performed on the end of the cable dielectric with a special tool. Ignition sealing compound, such as Dow-Corning No. 4 should always be used on the faces of the dielectric mating parts of these connectors.

LT series connectors are actually an extension of the LC series designed to accept RG-117 and -118/U size cables. They have been improved greatly by specialized design, and several models are now manufactured for use at elevated frequencies. It should be noted that the LT series is similar to but not interchangeable with the LC series; an adapter is available which allows connection of this series to the LC series.



SERIES QDS

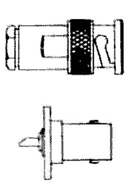
SERIES QDS The QDS series of connectors is an advanced version of the QDL series which was designed primarily for use aboard submarines to replace the LC series. This series uses a "push-pull" locking ball coupling arrangement similar to that found on air line hoses. This arrangement reduces coupling-decoupling time considerably. The QDS series are weatherproof, 50 ohm connectors for use with medium sized coaxial cables such as RG-8/U. These connectors are rapidly connected and disconnected and overcome the "rocking" tendency found in the bayonet type C and BNC series. QDS connectors employ an improved metal-to-metal cable clamping mechanism that provides a practical upper frequency limit of 10,000 mc.



SERIES BN

SERIES BN BN series connectors are small, lightweight connectors designed for use with small cables such as RG-58 and -59/U. Actually, they might be called small-size "N" connectors. They may be used for video, *if*, and other low power rf applications. These connectors are not electrically matched or weatherproof, and therefore are not recommended for applications at frequencies in excess of approximately 200 mc unless the electrical requirements of the circuit are not critical. They may be used at peak voltages up to 250 volts. Since the advent of the BNC

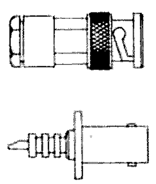
connector, their use has been virtually eliminated except for replacement purposes on very old equipment.


SERIES BNC

SERIES BNC This small connector design is probably the best known series in use at the present time. It was the first reliable quick connect and disconnect series; all the other connectors in early use used screw coupling. The bayonet coupling permitted rapid connections to be made and as such they made a tremendous hit in the test equipment field. These connectors are similar in size to the BN series but electrically they are greatly improved; original designs showed them to have an SWR of 1.15 from 1 to 3000 mc.

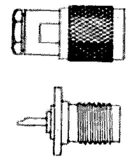
BNC connectors are of constant impedance with a nominal value of 50 ohms, and introduce little discontinuity in 50 ohm coaxial circuits employing small cables such as RG-58/U. Where some electrical mismatch is allowable, they may be used with other small and medium sized cables.

These connectors are fully weatherproofed and rated for use where the maximum voltage does not exceed 500 volts. They are available in standard, improved and captivated contact clamping arrangements. The improved connectors have been redesigned to give low standing wave ratios up to 10,000 mc in 50 ohm circuits. They are available with Teflon insulators which allow high temperature operation, and feature heat-treated beryllium copper spring fingers for both inner and outer contacts. There connectors are also available in polarized and pressurized versions.


SERIES MHV

SERIES MHV MHV series connectors are miniature high voltage connectors employing a bayonet-lock coupling similar to the BNC series. They are designed for small cables such as RG-58/U, and may be used at frequencies up to 50 mc. They may be used at peak voltages up to 5000 volts with a maximum current rating of 5 amps.

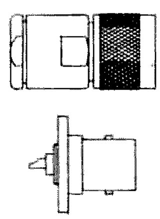
These connectors are similar to, but will not mate with, the series BNC connectors. They are weatherproofed with silicone rubber gaskets and feature the same metal-to-metal cable clamping mechanism used in the improved BNC series.


SERIES TNC

SERIES TNC Where in previous years great emphasis was put on ease of connection, the advent of high speed aircraft and missiles with their inherently stringent environmental requirements forced a return to the more positive vibration-proof threaded coupling. As a result the TNC series was created. Originally merely a threaded version of the BNC series prescribed for moderate frequency applications, increased usage at elevated frequencies through 10,000 mc has required manufacturing techniques far beyond those originally required for the BNC series.

The threaded coupling and safety wire provisions of the TNC series insure locking and secure mating under the most severe conditions of vibration and shock. Heat-treated beryllium copper spring fingers are used for both inner and outer contacts, thus providing positive contact during vibration and a substantial reduction in noise level.

These connectors are rated at 500 volts and have been designed to give low standing wave ratios at frequencies up to 10,000 mc in 50 ohm circuits. They feature clamping of the improved BNC type and are gasketed for weatherproof operation. Normally the TNC series is not used except in the stringent environmental conditions encountered in high speed aircraft or missiles.


SERIES C

SERIES C When originally designed the C series represented a big step forward in electrical performance at the higher frequencies. These connectors are for use with the same size cables as the N series but employ the mechanical advantage of bayonet coupling. This series introduced the new improved cable clamping mechanism wherein the cable gasket is actually cut when the clamp nut is tightened. This action gives good electrical contact for the cable shield and improves cable retention.

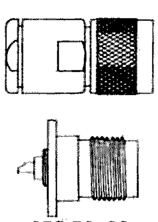
The C series is recommended where fast connection and disconnection by means of the bayonet lock coupling is required. For these purposes, this series is ideal. They are of constant impedance and may be used with minimum mismatch in 50 ohm circuits employing medium size cables such as RG-8/U. However, where matching requirements are not critical, they may also be used with either

Description					Military Number	Engineering Data
BNC	Female	to	C	Male	UG-636A/U	
BNC	Female	to	HN	Male	UG309/U	
BNC	Female	to	N	Male	UG-201A/U	
BNC	Female	to	N	Female	UG-606/U	
BNC	Female	to	QDS	Male	UG-1146/U	
BNC	Female	to	SM	Female	UG-690/U	Not Weatherproof
BNC	Female	to	SM	Male	UG-691/U	Pressurized
BNC	Female	to	UHF	Female	UG-255/U	Not Weatherproof
BNC	Female	to	UHF	Male	UG-273/U	Not Weatherproof
BNC	Female	to	Banana Jacks		UG-1035/U	
BNC	Male	to	C	Female	UG-635/U	
BNC	Male	to	HN	Female	UG-559B/U	Right Angle
BNC	Male	to	N	Female	UG-335/U	Flange Mounting
BNC	Male	to	N	Female	UG-349B/U	
BNC	Male	to	N	Male	UG-1034/U	Not Weatherproof
BNC	Male	to	QDS	Female	UG-1136/U	
BNC	Male	to	Banana Jacks		UG-978/U	
BNC	Male	to	Banana Plugs		UG-987/U	
BNC	Male	to	Binding Post		UG-282/U	
N	Female	to	BN	Male	UG-605/U	
N	Female	to	BNC	Female	UG-606/U	
N	Female	to	BNC	Male	UG-335/U	Flange Mounting
N	Female	to	BNC	Male	UG-349B/U	
N	Female	to	C	Male	UG-565/U	
N	Female	to	HN	Female	UG-1107/U	
N	Female	to	HN	Male	UG-1108/U	
N	Female	to	LC	Male	UG-999A/U	
N	Female	to	LN	Female	UG-108A/U	
N	Female	to	QDS	Male	UG-1144/U	
N	Female	to	UHF	Male	UG-83B/U	Not Weatherproof
N	Male	to	BNC	Female	UG-201A/U	
N	Male	to	BNC	Male	UG-1034/U	Not Weatherproof
N	Male	to	C	Female	UG-564/U	
N	Male	to	LN	Male	UG-213A/U	
N	Male	to	QDS	Female	UG-966/U	
N	Male	to	UHF	Female	UG-318/U	Not Weatherproof
N	Male	to	UHF	Male	UG-146A/U	Not Weatherproof
UHF	Female	to	BN	Male	UG-241/U	Not Weatherproof
UHF	Female	to	BNC	Female	UG-255/U	Not Weatherproof
UHF	Female	to	N	Male	UG-146A/U	Not Weatherproof
UHF	Female	to	Twin	Male	UG-970/U	Right Angle
UHF	Female	to	Banana Jack		UG-1017/U	
UHF	Female	to	Brittish 10H588		UG-197/U	
UHF	Male	to	BNC	Female	UG-273/U	Not Weatherproof
UHF	Male	to	C	Female	UG-637/U	Not Weatherproof
UHF	Male	to	N	Female	UG-83B/U	Not Weatherproof
UHF	Male	to	N	Male	UG-318/U	Not Weatherproof
UHF	Male	to	Binding Post		UG-332/U	
UHF	Male	to	British 10H365		UG-171/U	

Table 2. Coaxial connector guide adapters between different series.

larger or smaller cables.

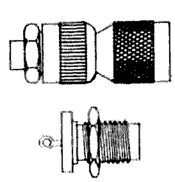
These weatherproof connectors have a maximum peak voltage rating of 1500 volts and a practical frequency limit of 10,000 mc. There is a high voltage version made for use up to 4000 volts peak, but this connector should not be used in applications above 2000 mc.



SERIES SC

SERIES SC SC Connectors are a threaded coupling version of the C series and represent an upgrading of the C connectors similar to the BNC-TNC improvement. The threaded coupling and safety wire provisions insure locking and secure mating under the most extreme conditions of vibration and shock.

This series has a maximum peak voltage rating of 1500 volts and provides low standing wave ratios at frequencies up to 10,000 mc in 50 ohm circuits. Like the TNC series, these connectors are not ordinarily used except under the stringent environmental conditions found in high speed aircraft and missiles.



SERIES SM

SERIES SM This series was designed for use inside equipment which does not require the weatherproof features found in present connectors. They employ the screw type design similar to the old BN series and in some ways could be called improved BN connectors. They were developed to fulfill the

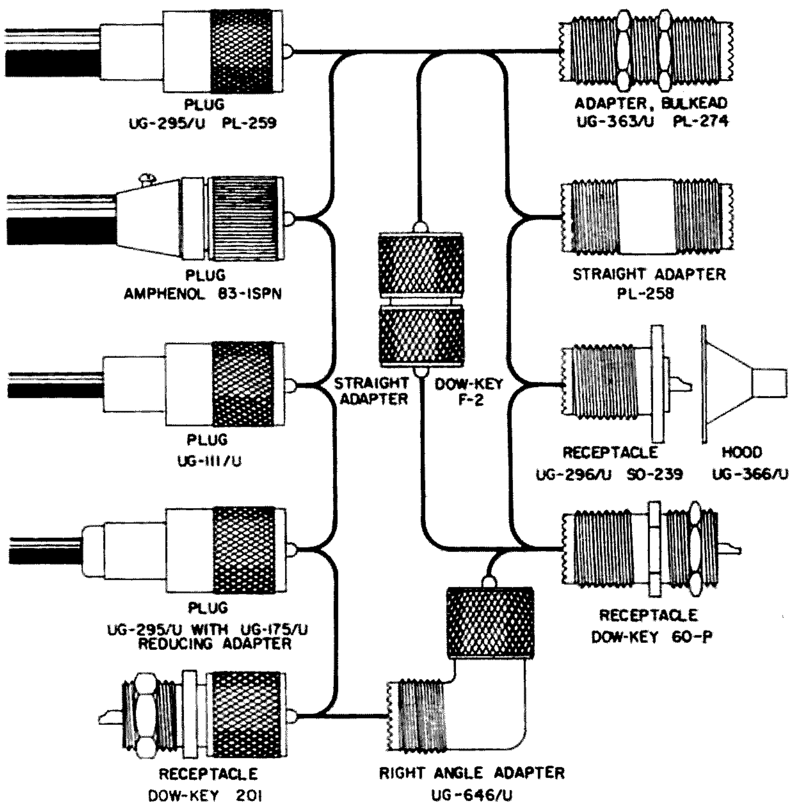
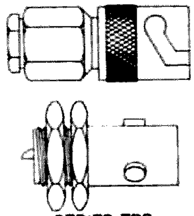


Fig. 2. UHF connector family.

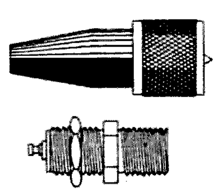
need for a small rf fitting for use with coaxial cables of ¼ inch overall diameter and smaller. They should not be used where electrical matching is required.

SM connectors are considerably smaller and contain fewer parts than the BNC series; for simplicity of design, they employ a female contact on the plug and a male contact on the jack and receptacle. The SM series has the advantage of positive braid clamping and does not use the inner conductor of the cable as the center contact. These connectors are not intended to replace the BNC series except for internal equipment connections where weatherproofness is not required. Its useful range is presently limited to frequencies below 1000 mc and peak voltages below 100 volts.



SERIES TPS

SERIES TPS A recent development of the Signal Corps, this three-pronged bayonet coupled series is slightly smaller than the BNC series and larger than the SM series. These connectors are weatherproof and produce minimum electrical discontinuities in small size solid dielectric 50 ohm coaxial cables up to 10,000 mc. They are rated at 1500 volts RMS at sea level. The method of cable clamping is a wedge type device that when used with RG-59/U type cables, provides a minimum cable retention of 45 pounds.



SUBMINIATURE

SUBMINIATURE Because of the tremendous number of subminiature connectors manufactured by the various connector companies, it is impossible to cover all of them here. The inset drawing is just representative of the many varieties available. The majority of these connectors are recommended for use in test equipment, video leads, communications receivers. *if* and rf circuits or wherever miniaturization is a factor. In fact, several manufacturers have printed circuit models of receptacles and terminations.

Subminiature connectors are available in threaded, bayonet, push-on and snap on versions with nominal impedances of 50, 75 and 93 ohms. Some units are weatherproof and various sizes are made to accommodate cables to ¼ inch in diameter. Because of their small

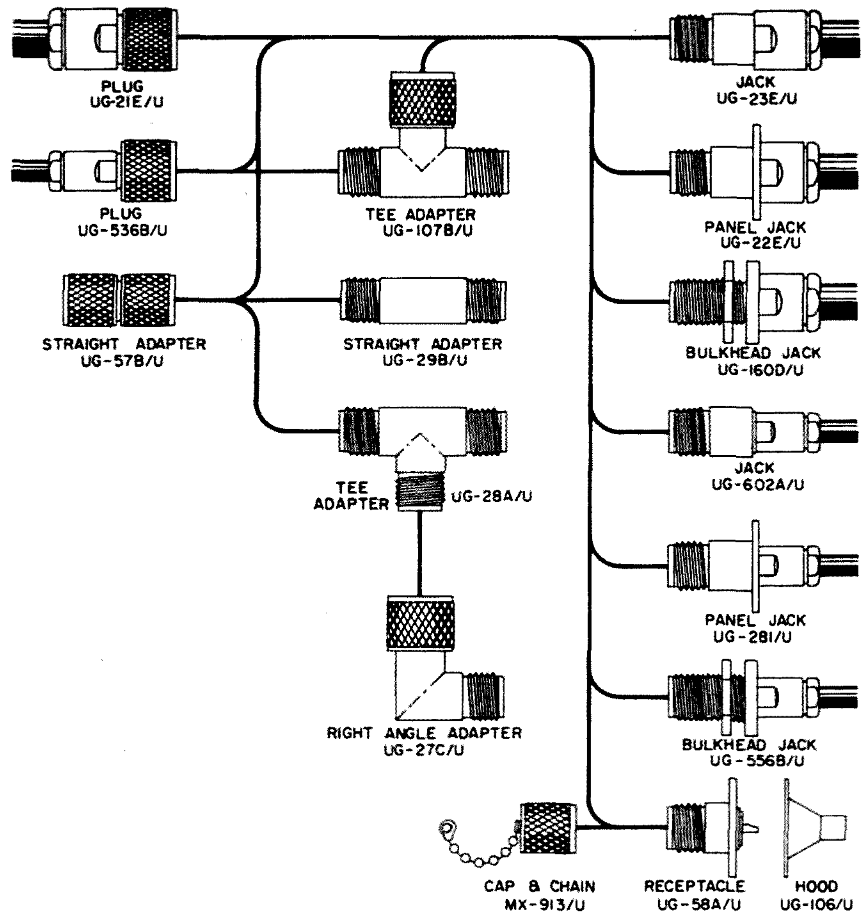
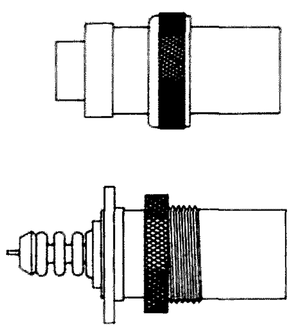


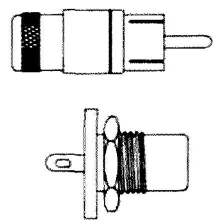
Fig. 3. Series N connector family.

size, many of these connectors are usable up to 3000 mc. Typical of these connectors are the Sub Minax series by Amphenol, the BSM and MTM series by Automatic Metal Products and the OSM connector made by Omni Spectra, Inc.



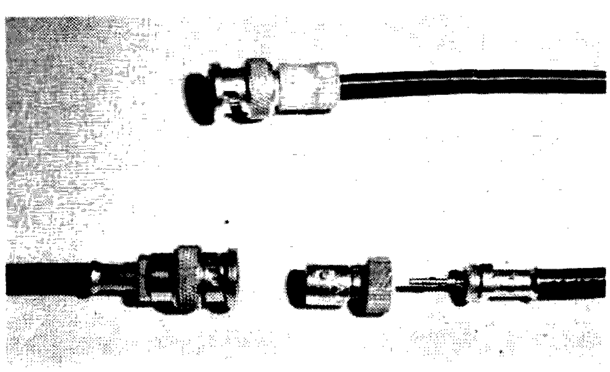
PULSE

PULSE Several varieties of connectors have been developed for high voltage pulse applications, particularly for radar. The pulse connectors with ceramic inserts are divided into two groups known as types A and B. The Pulse A connectors are widely used on U. S. Navy aircraft and at high altitudes they occasionally arc across the ceramic dielectric. However, as soon as the voltage stress is removed, they are again usable. The chief difficulty of the Pulse A connector is that inadequate bonding between mating connectors creates excessive noise when used near communications equipment. Pulse B connectors are considered standard for shipboard and ground equipment and may be used up to 15,000 volts peak. The Pulse B connectors also suffer from the tendency to leak noise.



PHONO

PHONO Phono connectors were originally designed for interconnection of shielded audio cables, but modern versions with nylon and ceramic insulation are suitable for low-power rf applications. These connectors are somewhat limited in use,



Labor saving coax connectors. In the front is a crimped type. An automatic Metal Products "Wedge-eze" is in the rear.

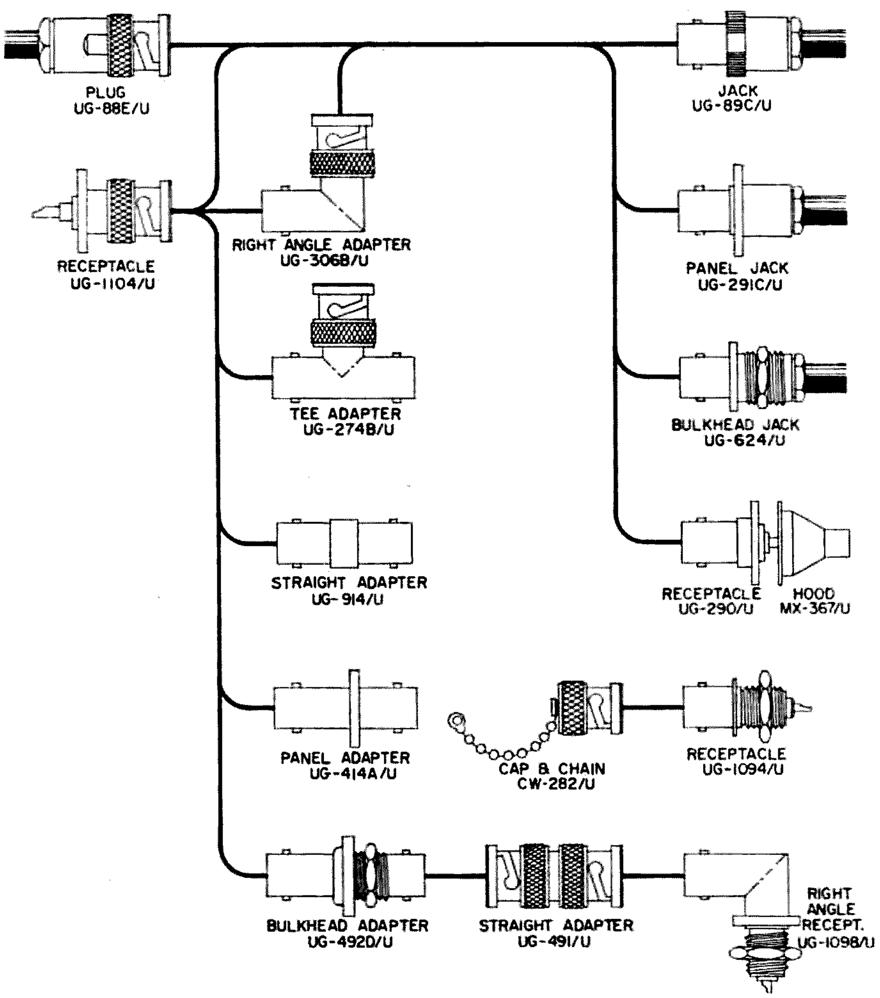


Fig. 4. Series BNC connector family.

but are economical, easy to assemble and provide a simple method for interconnection of receivers, VFO's, *if* strips, and other low-power equipment. These connectors do not provide 360° contact with the cable braid so there is some radiation loss at frequencies above one megacycle. They are not moisture-proofed and are intended only for indoor applications. Photo connectors have been used to a limited extent up to 150 mc, but the BNC, N or even UHF series do a better job and should be used instead of the photo connector in all but the least critical areas.

SERIES QL and QM (Not illustrated) These connectors are a recent development of the Signal Corps which feature a quick lead thread and are intended for high power, high voltage, low SWR connections with large size coaxial cables such as RG-217, -218, -219, -220, and -221/U where LC, LT, C and N connectors have been used in the past. These connectors provide a maximum SWR of 1.27:1 in mated pairs of cable assemblies up to 5000 mc.

SERIES SKL (Not illustrated) This type connector was originally designed to provide connections to klystron tubes, and various modifications were subsequently added to provide general-purpose cable to cable connections. Unfortunately, some of these connectors are still in use today even though the BNC would do a much better job. Furthermore, existing standard types such as the BNC and N perform the same function and are more generally available than the SKL series.

Special connectors

There are several special types of coaxial connectors and adapters that should be mentioned. Perhaps the most important of these are the between series adapters. These adapters provide an efficient electrical and mechanical transition between two different rf series. They are of non-constant impedance, but are designed so that the inherent electrical discontinuities are minimized. Although the straight adapter is the most common, other configurations are available to satisfy nearly any requirement; from straight and bulkhead adapters to angles, crosses and tees. A complete listing of between series adapters

for BNC, N and UHF to other types is listed in Table 2.

Transitions and splices

Terminations or end seals are a very helpful class of connector not normally encountered by amateurs. These devices provide a convenient, mechanical method for securing the end of a coaxial cable. A neat, connector-type braid clamp grounds the braid to the chassis terminal and allows the cable dielectric and inner conductor to extend for any convenient length for direct connection to a component. A variety of mounting arrangements are available as shown in **Fig. 5.** BNC or N connector techniques are employed in the assembly of these units.

Cable end seals are usually used in one of two ways; either as a termination or for strain relief. The termination is designed so that the jacket and braid of the cable are clamped within the body of the connector, while the dielectric and inner conductor are allowed to continue through. The strain relief variety is used for support only and the entire cable is allowed to continue through the body of the connector.

Cable splices are another class of connector which is not too familiar. These special connectors provide a convenient and neat workmanship method of joining two, three or four coaxial cables with a minimum of impedance mismatch. Splices are available in three basic configurations: tee, cross and transition as shown in **Fig. 6.** The tee and cross versions provide an efficient junction point for three or four cables and are especially useful in antenna phasing assemblies or similar applications. They may be used for continuation of the cable shielding or for inserting instruments in the circuit. They are also used for locating resistors and other components within the splice, or simply to save time and work in the repair of defective coaxial cable. The transitions may be used for splicing two similar or dissimilar cables. Normally the tees and crosses are gasketed for weatherproof operation while the transitions are non-weatherproof.

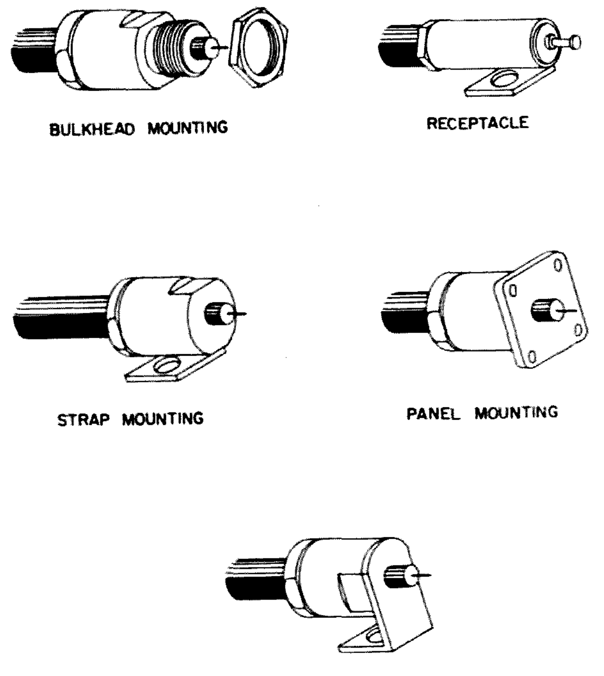
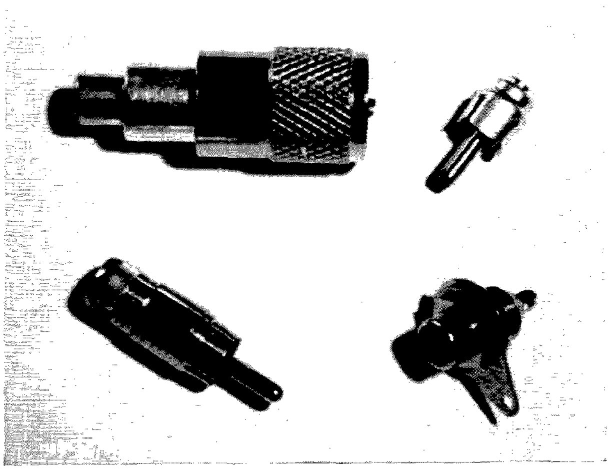


Fig. 5. Terminations.

Coaxial connector selection

Because of their importance in high frequency connector work, a considerable amount of experimental data on coaxial cable discontinuities has been accumulated and rather



Phono connectors. Clockwise from upper left: phono to series UHF adapter, cable plug, chassis receptacle and improved cable plug.

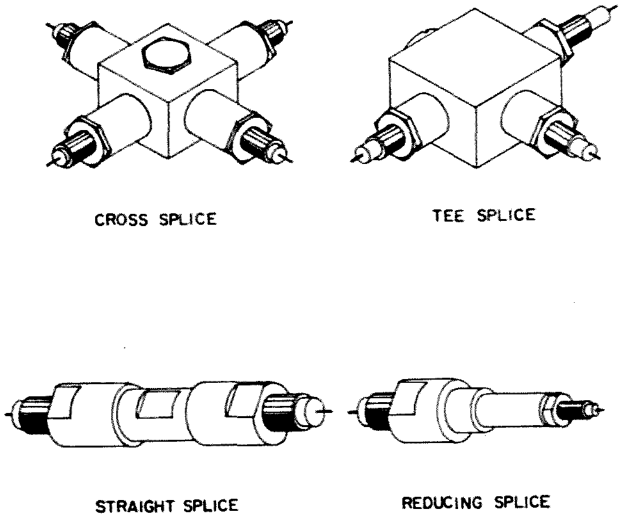


Fig. 6. Coaxial cable splicing hardware.

For RG/U Cables	Plug	Jack	Panel Jack	Bulkhead Jack	Hood	Engineering Data
RG-8/U	UG-959/U	—	—	—	—	Non-constant impedance
RG-58/U	UG-88E/U	UG-89C/U	UG-291/U	UG-909B/U	MX-195A/U	
RG-59/U	UG-260D/U	UG-261C/U	UG-262/U	UG-910B/U	MX-195A/U	
RG-122/U	UG-1082/U	UG-1056/U	UG-1055/U	—	MX-195A/U	

Table 3A. Coaxial connector selection guide for BNC series.

For RG/U Cables	Plug	Jack	Panel Jack	Bulkhead Jack	Hood	Engineering Data
RG-5/U	UG-626B/U	UG-633A/U	UG-629A/U	UG-630A/U	UG-570A/U	Impedance Mismatched
RG-8/U	UG-573B/U	UG-572A/U	UG-571A/U	UG-937A/U	UG-570A/U	
RG-11/U	UG-573B/U	UG-572A/U	UG-571A/U	UG-937A/U	MX-1144/U	
RG-17&U	UG-708B/U	—	—	—	—	
RG-58/U	UG-709B/U	—	—	—	MX-1870/U	
RG-59/U	UG-627B&U	—	—	—	MX-1870/U	

Table 4A. Coaxial connector selection guide for series C.

sophisticated matching techniques have been used by the connector manufacturers to produce connectors having high electrical and mechanical qualities for almost every coaxial cable in common use.

The large variety of connectors and cables, each designed to fit a specific need, and the almost infinite number of combinations available from them, indicates that the problem of selecting the proper connector is unique to the type of service required. Essentially, the selection of a cable connector boils down to the same requirements as the selection of the transmission line; i.e. SWR, attenuation, mechanical strength, and power and voltage limits. Since the desired operating requirements usually contain some conflicting requirements, such as long cable length and low attenuation, the most successful approach is very often to find the best compromise in available cables and connectors to fit the specific application.

One of the best criteria on which to base connector selection is that of the standing wave ratio at the frequency of operation. Fig. 7 charts the nominal standing wave ratio

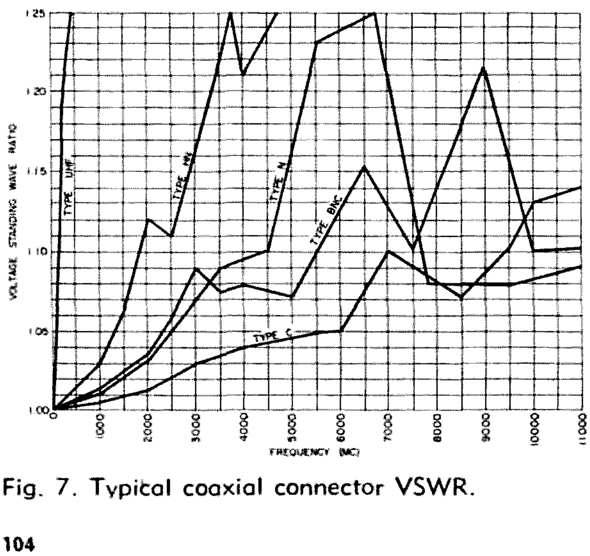


Fig. 7. Typical coaxial connector VSWR.

Description	Military Number	Engineering Data
Adapter, Binding Post	UG-282/U	
Adapter, Bulkhead (F-F)	UG-492D/U	Pressurized
Adapter, Feedthrough (F-F)	UG-914/U	
Adapter, Feedthrough (F-F)	UG-414A/U	Flange Mounting
Adapter, Right Angle (M-F)	UG-306B/U	
Adapter, Straight (M-M)	UG-491B/U	
Adapter, Tee (M-M-F)	UG-274B/U	
Cap and Chain (F)	CW-282/U	
Cap and Chain (M)	CW-123A/U	
Receptacle	UG-185/U	Flange Mounted
Receptacle	UG-290A/U	Teflon Insulation
Receptacle	UG-928/U	Rexolite Insulation
Receptacle, Bulkhead	UG-1094A/U	3/8" Thread Mounting
Receptacle, Male	UG-1104/U	3/8" Thread Mounting
Receptacle, Pressurized	UG-912A/U	7/16" Thread Mounting
Receptacle, Pressurized	UG-625B/U	1/2" Thread Mounting
Receptacle, Pressurized	UG-911A/U	Flange Mounted
Rectptacle, Right Angle	UG-535/U	3/8" Thread Mounting
Rectptacle, Right Angle	UG-1098A/U	

Table 3B. Miscellaneous series BNC connectors.

Description	Military Number	Engineering Data
Adapter, Bulkhead (F-F)	UG-701/U	Pressurized
Adapter, Bulkhead (F-F)	UG-1138/U	
Adapter, Right Angle (M-F)	UG-567A/U	
Adapter, Straight (F-F)	UG-643/U	
Adapter, Straight (M-M)	UG-642A/U	
Adapter, Tee (F-M-F)	UG-566A/U	
Cap and Chain (M)	UG-1142/U	
Cap and Chain (F)	UG-1143/U	
Receptacle, Bulkhead	UG-569/U	¾" Thread Mounting
Receptacle, Bulkhead	UG-705/U	Presusrized
Receptacle, Panel	UG-568/U	

Table 4B. Miscellaneous series C connectors.

For RG/U Cables	Plug	Jack	Panel Jack	Bulkhead Jack	Hood	Engineering Data
RG-5/U	UG-18D/U	UG-20D/U	UG-19D/U	UG-159C/U	UG-106/U	
RG-6/U	UG-91A/U	UG-92A/U	UG-93A/U	—	UG-106/U	70 Ohm Connectors
RG-8/U	UG-21E/U	UG-23E/U	UG-22E/U	UG-160D/U	UG-106/U	Improved Type
RG-8/U	UG-1185A/U	UG-1186A/U	UG-1187/U	—	—	Captivated Contacts
RG-11/U	UG-94A/U	UG-95A/U	UG-96A/U	—	UG-106/U	70 Ohm Connectors
RG-17/U	UG-167E&U	—	—	—	—	
RG-58/U	UG-536B&U	—	UG-1095B/U	UG-556B/U	UG-177/U	
RG-59/U	UG-603A/U	UG-602A/U	UG-593A/U	—	UG-366/U	

Table 5A. Coaxial connector selection guide for series N.

For RG/U Cables	Plugs	Reducing Adapters	Hoods
RG-8/U	PL-259, PL-259A, UG-295/U	—	MX-543/U, MX-372/U
RG-58/U	UG-175/U adater to PL-259	UG-175, UG-410/U	UG-177/U, MX-539/U
RG-59/U	UG-73/U, UG-111/U, UG-203/U	UG-176/U	UG-239/U, UG-366/U

Table 6A. Coaxial connector selection guide for series UHF.

Description	Military Number	Engineering Data
Adapter, Bulkhead (F-F)	UG-30D/U	Pressurized
Adapter, Right Angle (M-F)	UG-27C/U	
Adapter, Right Angle (F-F)	UG-202A/U	Panel Mounting
Adapter, Straight (F-F)	UG-29B/U	
Adapter, Straight (F-F)	UG-1018/U	Not Weatherproof
Adapter, Storight (M-M)	UG-57B/U	
Adapter, Tee (F-F-F)	UG-28A/U	
Adapter, Tee (F-F-M)	UG-464/U	
Adapter, Tee (F-M-F)	UG-107B/U	
Cap and Chain	MX-913/U	
Receptacle	UG-58A/U	70 Ohm Impedence
Receptacle	UG-231/U	With Hood
Receptacle	UG-367/U	
Receptacle	UG-680A/U	Pressurized
Receptacle, Right Angle	UG-997A/U	

Table 5B. Miscellaneous series N connectors.

Description	Military Number	Engineering Data
Adapter, Bulkhead (F-F)	UG-224/U	Rexolite Insulation
Adapter, Bulkhead (F-F)	UG-300/U	
Adapter, Bulkhead (F-F)	UG-363/U	Polystyrene Insulation
Adapter, Bulkhead (F-F)	PL-274	
Adapter, Right Angle (M-F)	UG-297A/U	
Adapter, Right Angle (M-F)	UG-646/U	Polystyrene Insulation
Adapter, Straight (F-F)	UG-299/U	
Adapter, Straight (F-F)	UG-360/U	Polystyrene Insulation
Adapter, Straight (F-F)	PL-258	
Adapter, Straight (F-F)	UG-307/U	Panel Mounting
Adapter, Tee (F-M-F)	UG-298/U	
Receptacle	UG-296/U	
Receptacle	SO-239	
Receptacle, Bulkhead	UG-223/U	
Receptacle, Pressurized	UG-266/U	Rexolite Insulation

Table 6B. Miscellaneous series UHF connectors.

of the more popular coaxial connectors at frequencies up to 11,000 mc. These curves are based on actual laboratory measurements of improved versions of connectors properly assembled to RG-8A/U cable except for the BNC connector which was assembled to RG-58/U cable. The non-constant impedance UHF series is shown for information purposes only, but it becomes quite obvious why this connector is not recommended for use at frequencies above 200 mc.

When selecting coaxial connectors, many factors must be considered; first of all, the coupling mechanism of the connector should be selected in accordance with the intended service. Where long, massive cables are to be joined, the coupling nut and associated retaining rings must be correspondingly strong such as those in **Fig. 8A**. When the completed assembly is to be used under conditions where frequent movement or vibration is anticipated, the connection must be strong, positive and vibration proof (**Fig. 8B** and **C**). For light duty where frequent connections and disconnections are required such as for test equipment, the connection should be quick and positive such as illustrated in **Fig. 8D.** Where severe space limitations prevent the use of threaded or bayonet mechanisms, push-on connectors with detent arrangements are useful (see **Fig. 8E**). In some applications "phono" connectors provide a simple and economical push-on connector (**Fig. 8F**).

Since final connector selection is essentially an electrical problem, transmission line practice is normally employed to determine the basic line parameters of impedance and SWR once the characteristic impedance of the system is known. When the ideal solution of these parameters has been found, average power, peak voltage and permissible power loss must be considered. In this phase, con-

For RG/U Cables	Plug	Panel Jack	Hood	Engineering Data
RG-22/U	UG-102/U	UG-103A/U	UG-106/U	Not Weatherprof
RG-22/U	UG-421B/U	UG-423B/U	—	Weatherproof

Table 7A. Coaxial connector selection guide for UHF twin series.

nector-cable combinations must be chosen that satisfy the operating requirements; at this point it is often necessary to make compromises in the final choice.

Connector-cable combinations that appear satisfactory from the standpoint of the electrical requirements should then be analyzed for operating temperature, mounting methods and coupling requirements. Many connectors that are employed internally do not require weatherproofing and a less expensive connector can frequently be used. In general, connectors which are used outside must be weatherproofed.

To reduce the SWR and impedance discontinuities to a minimum, coaxial connectors must be designed to have the same characteristic impedance as their mating cable. Actually, the objective is to make the connector a homogenous electrical extension of the cable itself. In this way the practical upper frequency limit of the complete assembly often exceeds 10,000 mc. Expansion, due to temperature, may cause a discontinuity by separating the cable from the clamp within the connector. For this reason, great emphasis is put on the metal-to-metal braid clamping mechanism using large contact areas. In some cases it is advantageous to insure that the center conductor is mechanically held in a fixed position by a captivated contact arrangement.

Additionally, coaxial connectors must be designed so that they operate safely at the maximum rating of the cables with which they are used. The most difficult of these requirements is the peak voltage rating. This is accomplished in several ways. First, physical changes where high voltage gradients might occur must be kept to a minimum; and second, a good high-quality dielectric must be used throughout the connector. Also, provisions should be made to avoid the development of air pockets at the mating boundaries of connector pairs.

Description	Military Number	Enginering Dat
Adapter, Right Angle (M-F)	UG-104/U	Not weatherproof
Adapter, Right Angle (M-F)	UG-931/U	Weatherproof
Adapter, Straight (F-F)	UG-105/U	Not weatherproof
Adapter, Straight (F-F)	UG-493A/U	Weatherproof
Adapter, Tee (F-M-F)	UG-196/U	Not weatherproof

Table 7B. Miscellaneous series UHF twin connectors.

Actually, connector selection is not nearly as complex as it might sound at first. For amateur application, there are only three types of connectors that are generally used; series UHF, BNC and N. These series will satisfy nearly any amateur requirement, but series C or phono connectors may be useful in some special applications.

The "Connector Selection Guides" in **Tables 3** through **7** were prepared as an aid in the selection of connectors for use with specific cables. The cables listed are those that are most apt to be used in amateur work. When selecting a connector for use with coaxial cables not listed in the "guide," reference to the "Coaxial Cable Assembly Groups" chart in **Table 8** may be helpful. In essence, there are fourteen main groups of RG-/U cables within the large number available. For example, RG-8A/U belongs to cable group "F" as do RG-9, -31, -87, -165, -213, -214 and -229/U. Therefore, connectors listed in the guide for RG-8/U may also be used with any of the other coaxial cables in the same assembly group.

Coaxial connector installation

It must be remembered that the primary function of the coaxial cable connector is electrical and every available provision should be made to support it mechanically. Occasionally, the mounting environment will prevent supporting the cable at intervals as often as desired and a larger, stronger connector must be used. In addition, the cable may be required to follow the contour of a building or corner or roof peak; in such a case, larger connectors should be used to preclude premature failures.

Many connectors are attached to panels or bulkhead partitions. There are three standard methods for attachment of these fittings. The most common is the "single hole mount"; the connector has an external thread and is locked to the panel with a hex nut and lock-washer. In some cases a method of keying the connector to the panel is employed. The three main types are single flat on the connector body requiring a "D" hole in the chassis, a

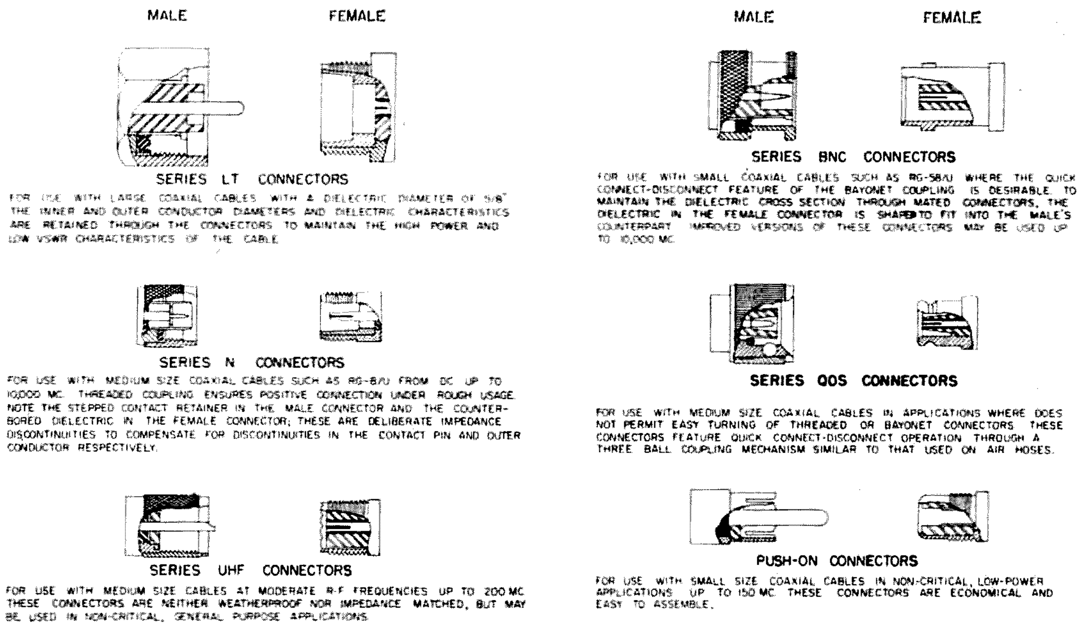


Fig. 8. Cutaway drawings of series LT, N, UHF, BNC, QDS and push-on connectors.

double flat requiring a special hole in the panel or a bent tab on the connector requiring a notched hole in the chassis. When large thick chassis are used, the connector may be screwed into, press fit or soldered to the chassis as desired.

Outdoor use of connectors

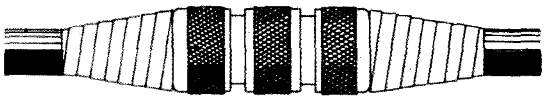
While steps have been taken in all of the more modern coaxial connectors to achieve moisture-proofing, none of the connectors may be classified as entirely waterproof and suitable for outdoor use unless protected by additional coverings. The most common practice used to protect the mating surface between plug and receptacle is to pack one side with silicone grease. The connectors are then mated and any excess grease is forced to the outside of the connector where it may be wiped off. The grease tends to dry and form voids after a period of time however, and should be replaced periodically. If not replaced, the voids within the grease may become water traps during periods of temperature change with high humidity. In some cases packing will adversely effect the operation of the cable at UHF frequencies. This is because matched connectors for use above 1000 mc utilize high impedance compensating air sections at the mating surfaces. Silicone grease has a greater dielectric constant than air and packing the mating surface results in a low impedance section with resultant mismatch.

An alternate and preferred method of weatherproofing is to utilize connectors with threaded mating surfaces such as type N or UHF. The mating threads on the receptacle side can be coated with a waterproof varnish such as Glyptal just prior to making the connection. Then, after assembly, the outer surface of the mated pair may be covered with the same varnish. UHF series connectors may be coated with varnish on the outside but not on the threaded surface, because in these connectors the rf current path takes place along the threaded surface. Unfortunately, the use of Glyptal varnish may only be used once since it renders connectors useless for future mating.

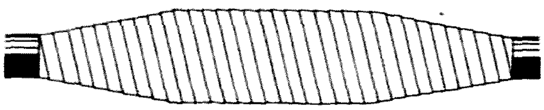
A third method of waterproofing coaxial connector assemblies is to wrap a good quality pressure-sensitive vinyl tape over the junction as shown in **Fig. 9.** As in the case of silicone grease protection, the tape should be periodically replaced.

For best results, the tape wrap should be installed in the following manner:

1. After the two lengths of cables are connected together, tightly wind tape behind each connector to obtain a smooth contour between connector and cable.
2. Tightly wrap several layers of tape over the entire assembly. Use a 50% overlap and wind each of the layers in opposite directions; a minimum of four layers should be used for maximum protection.
3. The completed tape covering should extend beyond each connector a minimum of eight times the diameter of the cable.



WIND PLASTIC ELECTRICAL TAPE AROUND CABLE IMMEDIATELY BEHIND CONNECTORS TO PROVIDE A SMOOTH CONTOUR BETWEEN CABLE AND CONNECTORS.



WRAP SEVERAL LAYERS OF TAPE WITH A 50% OVERLAP OVER THE CONNECTORS AND BUILT-UP JUNCTIONS. EACH OF THE LAYERS SHOULD BE WRAPPED IN REVERSE DIRECTIONS.

Fig. 9. Taping coaxial cable junctions.

The best method to remove the tape is to unwrap it. A knife may be used for this purpose, but care must be taken not to cut into the plastic jacket of the cable. The recommendation here is to cut the tape in the immediate vicinity of the metal connector and peel it off.

Coaxial connector assembly

The coaxial connector is a highly engineered device and even the smallest mechanical dimension or material characteristic may be of great electrical or mechanical significance. Accordingly, the cable assembly operation must carry out the objective of the original design if the connector is expected to operate to its fully intended capabilities.

Where the assembly instructions show the cable's dielectric butting the connector's dielectric, every precaution should be taken that the assembly method insures a positive butt. If the connector is to be used at ultra high frequencies with a low SWR, the development of air pockets because of loose butt joints or rounded dielectric corners will give rise to impedance mismatches proportional to the frequency of operation. In high voltage cables air pockets or loose joints materially reduce the peak voltage capability of the entire assembly.

Loose butt joints usually develop unless the dielectric trimming process is made one of the last assembly operations. Rounded corners develop because of excess heating during soldering or through a mistaken notion that all "sharp edges should be avoided." It is extremely important that the dielectric be cut at perfect right-angles to the center conductor; no notches should be permitted. Correct methods of stripping the cable dielectric and jacket are shown in **Fig. 10.**

Air pockets between the inner conductor and the dielectric of the cable usually develop due to excessive heat when soldering the center contact of the connector onto the inner conductor of the cable. Some of the dielectric is softened, and through movement of the inner conductor, a larger hole is formed.

Finally, precautions should be taken during the assembly process to insure that the center contact of the connector rests at its proper lateral position as shown in **Fig. 11.** In many connectors, the exact axial distance between a point on the connector shell and the tip of the pin is an electrical matching circuit. In type N connectors this is the case where the male pin steps down before entering the female pin of the mating connector, leaving a deliberate radial notch—compensated by the overhung iris in the inside dimension of the outer conductor.

Many times, misalignment results from assembling connectors to both ends of a relatively long cable while it is still coiled. When

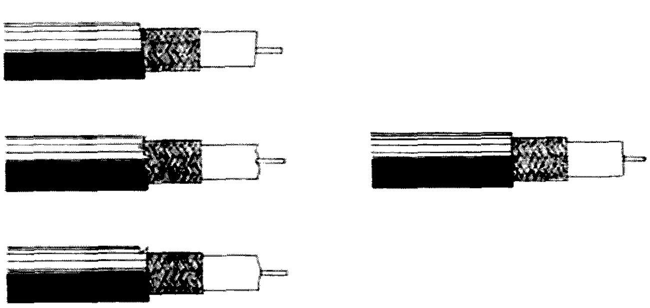


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Fig. 10. Stripping coax cable jacket and dielectric.

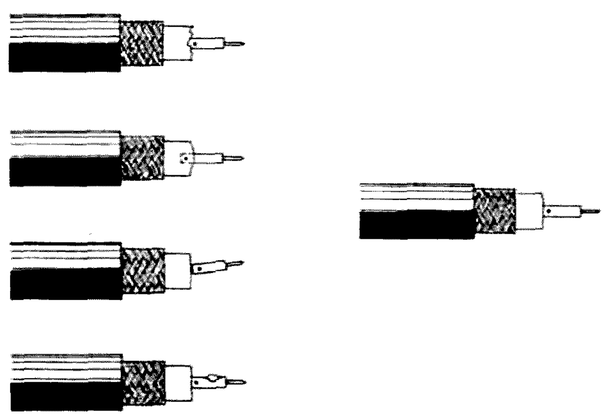

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Fig. 11. Installing center contact.

RG-/U	Cable Group	RG-/U	Cable Group	RG-/U	Cable Group
5	D	62	B	148	H
6	E	63	J	149	H
8	F	71	B	159	A
9	F	79	J	164	N
10	G	81	K	165	F
11	H	82	M	166	G
13	H	87	F	210	B
17	N	89	J	212	D
18	P	100	C	213	F
21	D	114	J	214	F
29	A	116	G	215	G
31	F	118	L	216	H
32	G	124	B	218	N
35	P	133	J	219	P
38	D	140	B	222	D
39	E	141	A	223	A
55	A	142	A	225	F
58	A	143	D	227	G
59	B	144	H	228	L

Table 8A. Coaxial cable assembly groups.

it is uncoiled, the ends of the center conductor may assume a different position with respect to the ends of the outer braid. For similar reasons, a connector should not be assembled to cable under temperature extremes.

Except for the UHF series of connectors, the only soldering operations encountered during connector to cable assembly is in joining the center contact of the connector to the inner conductor of the cable. However, there are two major precautions which must be observed during this operation. It is imperative that a good solder bond be made between the pin and the inner conductor of the cable over the entire depth of the pin. Otherwise, a significant inductive reactance may be created because the hole in the pin and the inner conductor form the conductors of a miniature short-circuited coaxial line having significant electrical length at UHF frequencies.

Also, any excess solder must be removed so that the step contour between the pin and the cable conductor corresponds essentially to the original dimensions. A change in dimensions because of excessive solder acts like a shunt capacitor and is in effect a circuit change within the connector.

Complete assembly instructions for type BNC, N and UHF connectors are provided in **Fig. 12 through 22.** Note that standard series N connectors come in two different versions, one with a v-groove gasket, the other with a cylindrical gasket, but that the assembly sequence is basically the same.

During connector assembly, there are five basic rules which must be followed to obtain proper operation.

1. Closely follow the recommended assembly instructions to insure proper SWR and voltage ratings.
2. Do not apply more heat than necessary during soldering operations. Use crimped or clamped connections on cable braid to prevent heat distortion of the dielectric.
3. Do not exert excessive force in tightening fittings containing rubber or plastic gaskets as permanent deformation will result; occasional light retightening is preferred.
4. Carefully remove all filings, loose solder and other foreign objects from the connectors prior to assembly; observe cleanliness during all operations. Extraneous matter in connectors reduces power and voltage ratings and increases the SWR of the assembly.
5. Use extreme care in the assembly and grounding of connectors operating at high voltages to reduce corona and radiated noise.

Cable Group	Center Conductor	Maximum Dimensions				RG-/U Cables	Impedance (ohms)
		Dielectric	Braid	Jacket	Armor		
A	0.040	0.121	0.177	0.216	—	29, 55, 58, 141,142, 159, 223	50
B	0,030	0.151	0.206	0.251	—	59, 124, 140	75
						62, 71, 210	93
C	0.096	0.151	0.206	0.251	—	100	35
D	0.061	0.194	0.263	0.342	—	5, 21, 38, 143, 212, 222	50
E	0.030	0.194	0.263	0.342	—	6, 39	75
F	0.096	0.295	0.357	0.435	—	8, 9, 31, 87, 165, 213, 214, 225	50
G	0.096	0.295	0.357	0.435	0.511	10, 32, 116, 166, 215, 227, 229	50
H	0.061	0.295	0.357	0.435	—	11, 13, 144, 148, 149, 216	75
J	0.030	0.295	0.357	0.435	—	133	95
						63, 79, 89, 144	125
K	0.081	0.334	0.379	—	—	81	50
L	0.198	0.640	0.670	0.745	0.813	118, 228	50
M	0.127	0.650	0.755	—	—	82	50
N	0.198	0.695	0.761	0.888	—	17, 218	50
						164	75
P	0.198	0.695	0.761	0.888	0.963	18, 219	50
						35	75

Table 8B. Coaxial cable assembly groups.

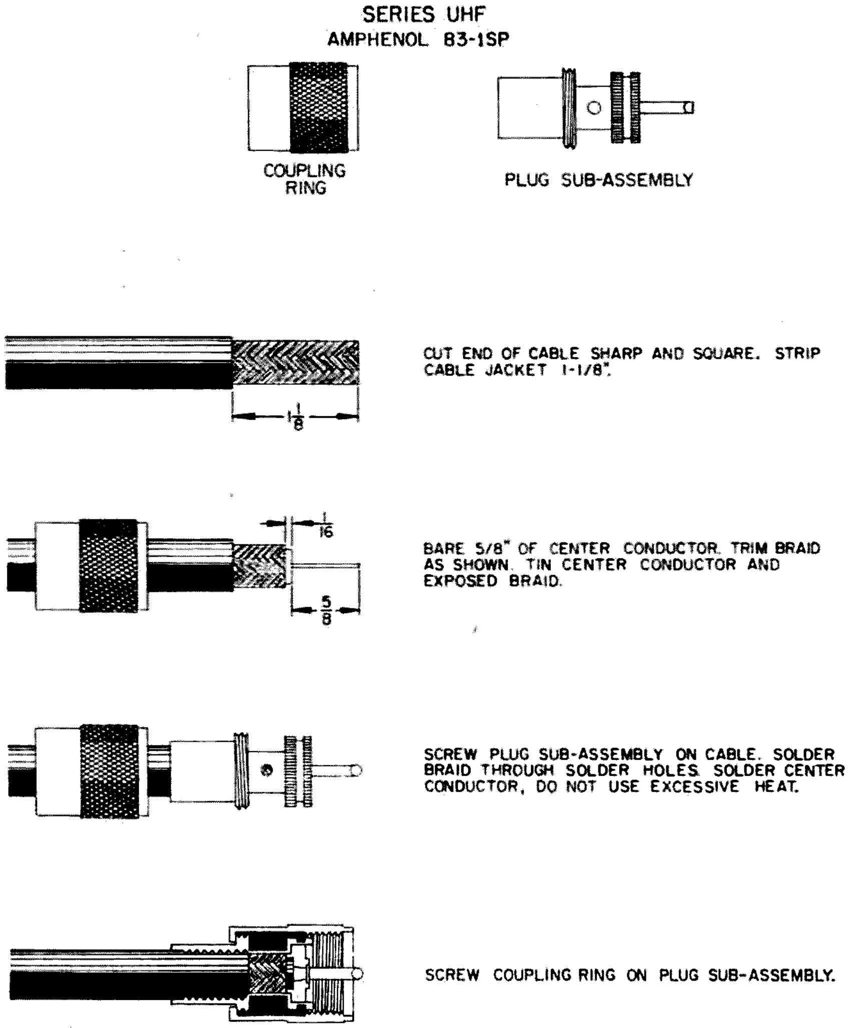


Fig. 12. Series UHF assembly instructions for Amphenol 83-1SP.

Coaxial connector assembly group charts

The "Coaxial Cable Assembly Group Charts" in **Table 8** are useful in selecting coaxial connectors for various size coaxial cables. The first part of the charts list 57 of the most popular coaxial cables and the lettered assembly group to which they belong. RG-8/U for example, is in assembly group "F."

The second part of the chart lists the dimensions of each of the cables within a group and their characteristic impedance. Cables within group "F" for example, include RG-8, -9, -31, -87, -165, -213, and -214/U.

The primary use of these charts is in the selection of coaxial connectors. In the "Coaxial Connector Index" in **Table 9**, only one type of RG-/U cable is listed for each connector. However, the same connector may be used with any other coaxial cable in the same assembly group. For example, the UG-21E/U type N improved plug is listed for cable type RG-8/U. This indicates that the UG-21E/U plug is suitable for any of the other cables in the "F" assembly group.

These charts are also useful when selecting connectors for cables which are not listed. In this event, the various dimensions of the cable are compared to the group chart to determine which group is most applicable; suitable connectors are then selected accordingly.

As an aid in connector selection, identification and assembly, the "Connector Index" in **Table 9** lists all of the type BNC, N and UHF coaxial connectors currently available along with description, type, equivalent Amphenol part number and applicable RG-/U cables. Many of these connectors have very subtle differences which may be recognized only from the information in the "engineering data" column of the table.

Type designation refers to standard (S), improved (I) and captivated contact (CC) assembly techniques. This index is indispensable in determining what method to use when assembling a particular connector.

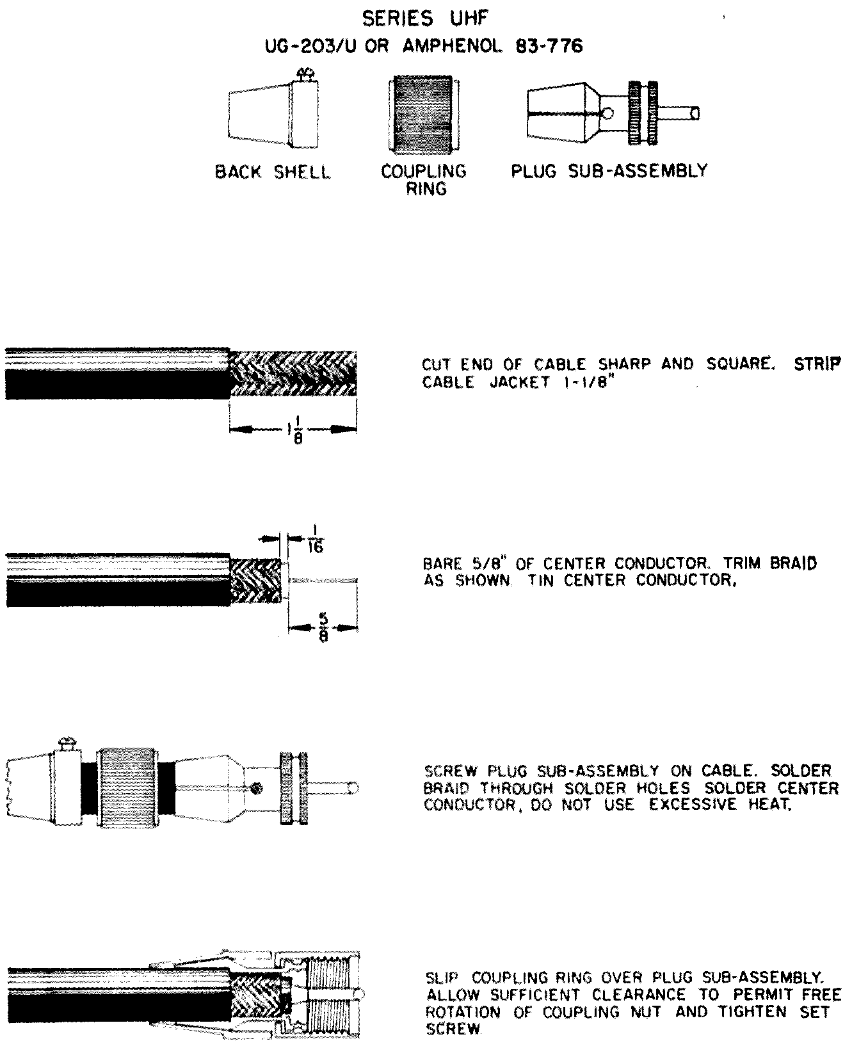


Fig. 13. Assembly instructions **for UHF series UG-203/U.**

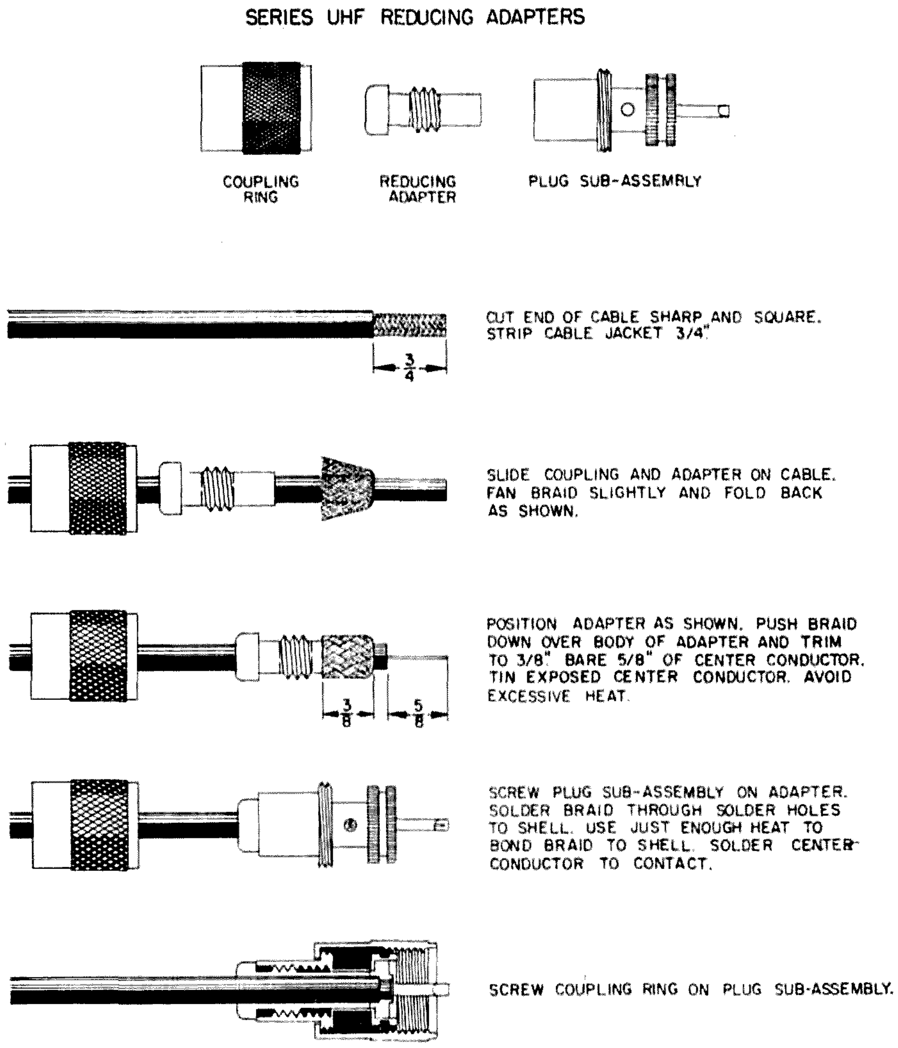
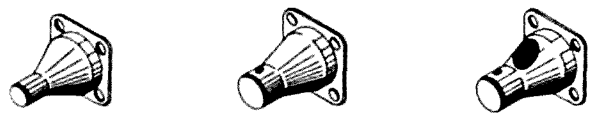
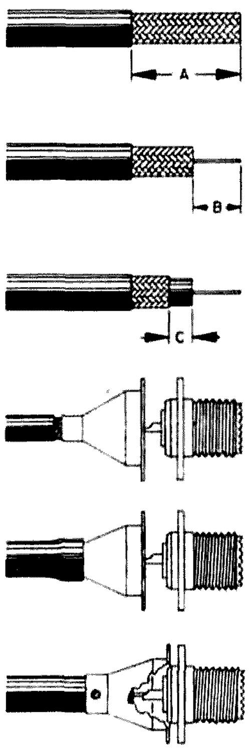


Fig. 14. Assembly instructions **for UHF series reducing adapters.**

SERIES UHF HOODS

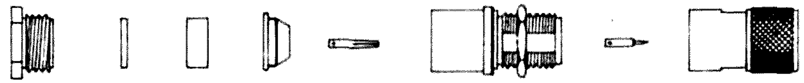


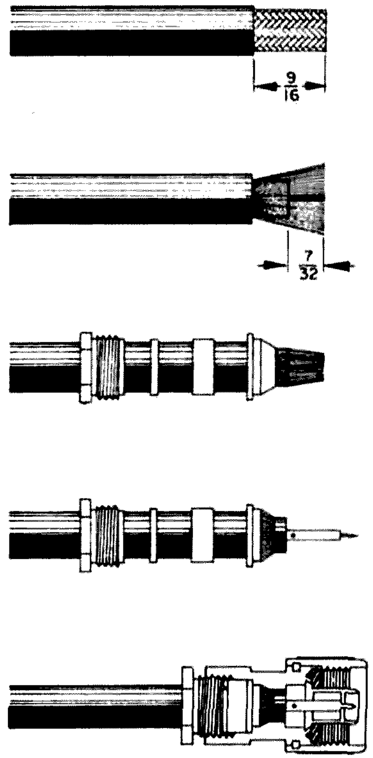


	UG-177/U	UG-106/U	UG-372/U
CUT END OF CABLE SHARP AND SQUARE. STRIP JACKET TO APPROPRIATE LENGTH	3/4	5/8	3/4
REMOVE BRAID AND DIELECTRIC TO DIMENSION SHOWN. TIN CENTER CONDUCTOR	5/16	5/16	5/16
STRIP BRAID FROM DIELECTRIC TO DIMENSION SHOWN. TIN BRAID	3/8	3/16	3/8
SLIDE HOOD OVER BRAID. SOLDER CONDUCTOR TO CONTACT. SLIDE HOOD FLUSH AGAINST RECEPTACLE AND TACK-SOLDER HOOD FLANGE TO RECEPTACLE FLANGE. SOLDER HOOD TO BRAID.	X		
SLIDE HOOD OVER BRAID AND FORCE UNDER JACKET. SOLDER CONDUCTOR TO CONTACT. PUSH HOOD FLUSH AGAINST RECEPTACLE. TACK-SOLDER HOOD TO BRAID THROUGH SOLDER HOLES. WITH DOUBLE BRAIDED CABLE HOOD GOES OVER INNER BRAID ONLY. OUTER BRAID IS SOLDERED TO OUTSIDE OF HOOD.		X	
SLIDE HOOD OVER BRAID. PUSH RECEPTACLE FLUSH AGAINST HOOD. SOLDER CONDUCTOR TO CONTACT AND HOOD TO BRAID.			X

Fig. 15. Assembly of UHF series hoods.

SERIES N





CUT END OF CABLE SHARP AND SQUARE. STRIP JACKET 9/16". STRIP 5/8" WHEN USING DOUBLE SHIELDED CABLE.

COMB OUT BRAID AS SHOWN. STRIP DIELECTRIC 7/32" FROM END. TIN CENTER CONDUCTOR.

TAPER SHIELD AND SLIDE NUT, WASHER AND GASKET OVER JACKET. INSTALL CLAMP SO THAT ITS INNER SHOULDER FITS SQUARELY AGAINST END OF CABLE JACKET.

FOLD BRAID BACK AS SHOWN AND TRIM PROPERLY. SOLDER CONTACT TO CENTER CONDUCTOR. AVOID EXCESSIVE HEAT.

SLIDE ASSEMBLY INTO CONNECTOR BODY. FACE OF DIELECTRIC MUST BE FLUSH AGAINST INSULATOR. INSERT NUT, SCREW IN PLACE AND TIGHTEN WITH WRENCH.

Fig. 16. Assembly of series N connectors.

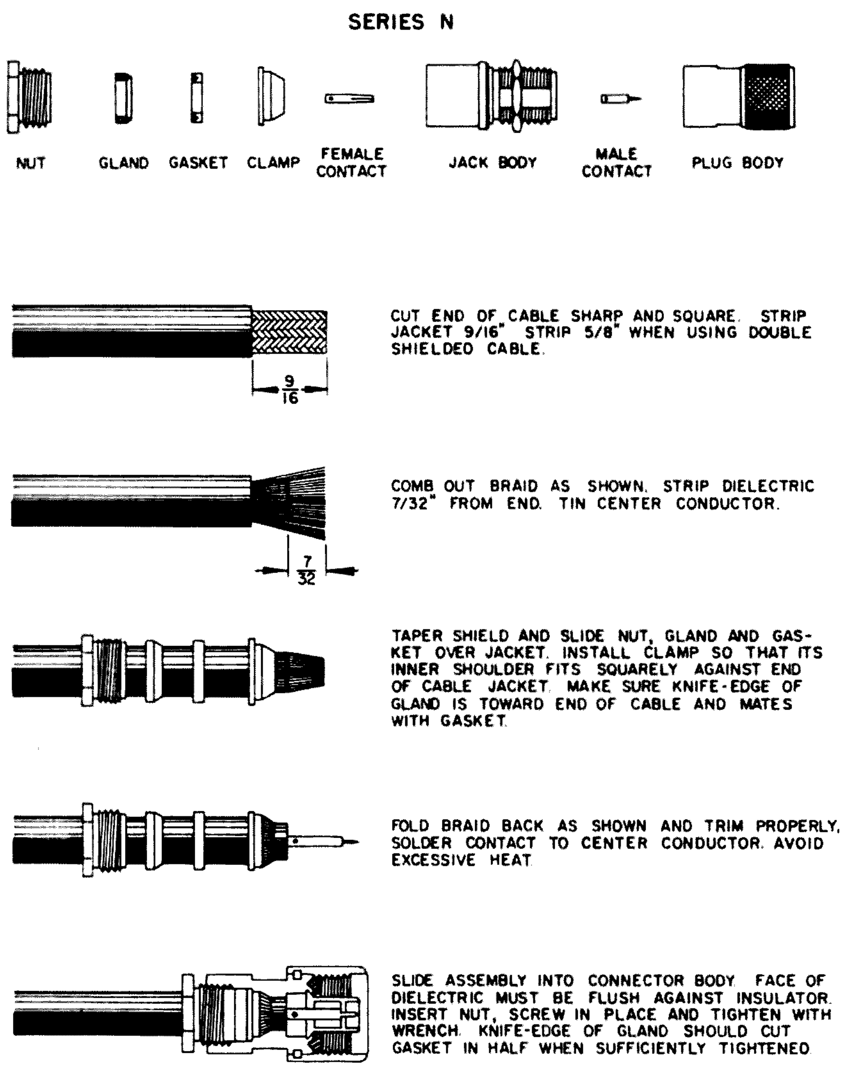


Fig. 17. Assembly of series N connectors.

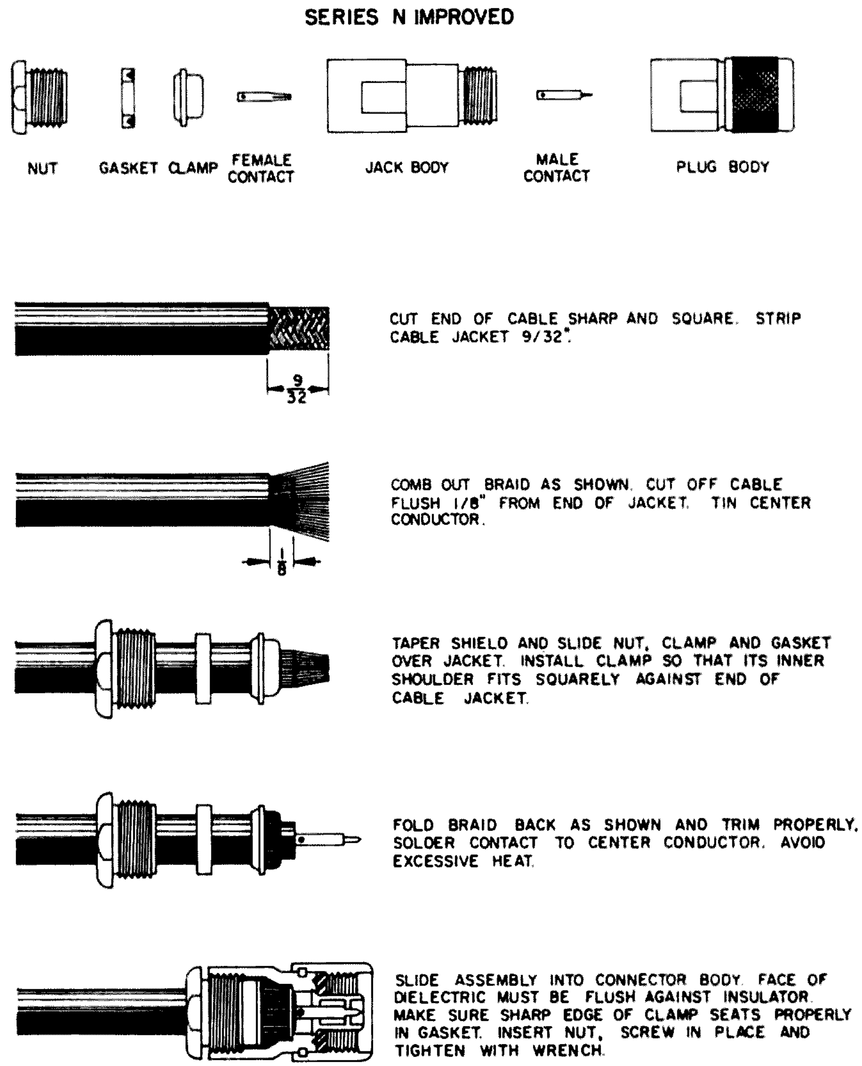
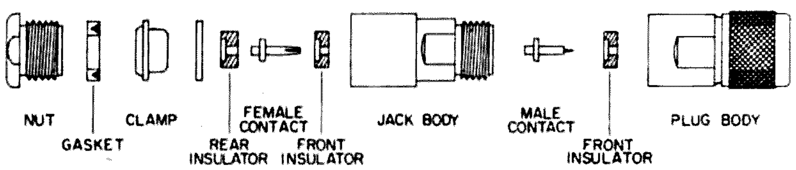
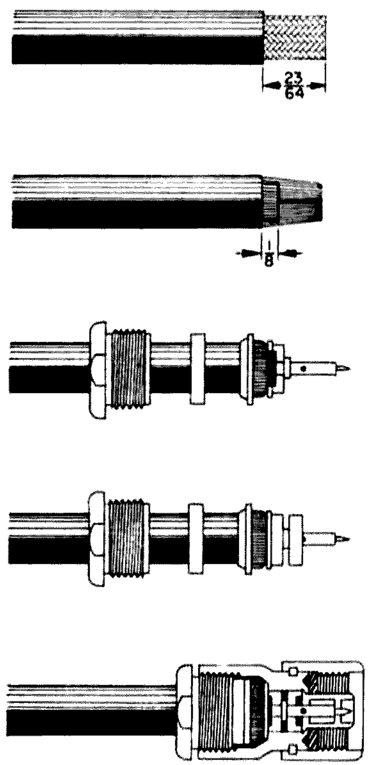


Fig. 18. Assembly of series N improved connectors.

SERIES N WITH CAPTIVATED CONTACTS





CUT END OF CABLE SHARP AND SQUARE. STRIP CABLE JACKET 23/64".

COMB OUT BRAID AS SHOWN. CUT OFF CABLE FLUSH 1/8" FROM END OF JACKET. TIN CENTER CONDUCTOR.

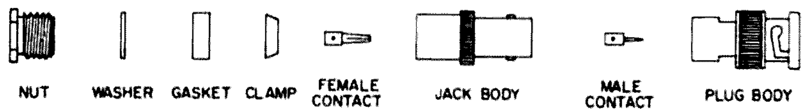
SLIDE NUT, GASKET AND CLAMP OVER JACKET. INSTALL CLAMP SO THAT ITS INNER SHOULDER FITS SQUARELY AGAINST END OF CABLE JACKET. FOLD BRAID BACK AS SHOWN AND TRIM PROPERLY. SLIDE ON WASHER, REAR INSULATOR AND CONTACT. CABLE CORE, INSULATOR AND CONTACT SHOULDER MUST BUTT AS SHOWN. SOLDER CONTACT TO CENTER CONDUCTOR. AVOID EXCESSIVE HEAT.

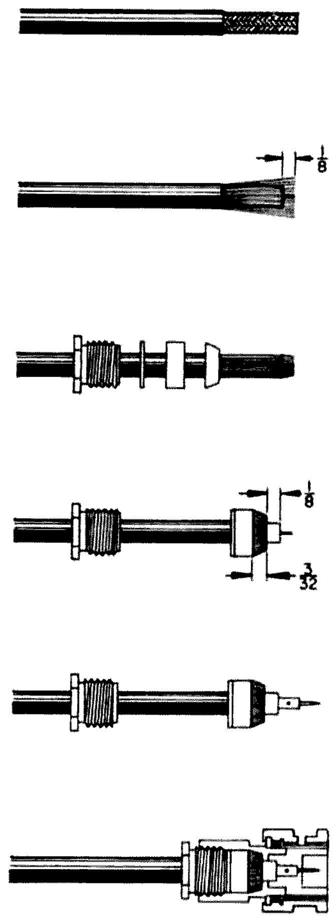
SLIDE FRONT INSULATOR OVER CONTACT. BE SURE TO PLACE COUNTER BORED END OF INSULATOR TOWARD MATING END OF CONTACT.

SLIDE ASSEMBLY INTO CONNECTOR BODY. MAKE SURE SHARP EDGE OF CLAMP SEATS PROPERLY IN GASKET. INSERT NUT, SCREW IN PLACE AND TIGHTEN WITH WRENCH.

Fig. 19. Assembly of series N with captivated contacts.

SERIES BNC





CUT END OF CABLE SHARP AND SQUARE. STRIP CABLE JACKET 19/64" FOR RG-58/U OR 5/16" FOR RG-59/U.

COMB OUT BRAID AND FLARE AS SHOWN. STRIP CENTER DIELECTRIC 1/8".

TAPER SHIELD AND SLIDE NUT, WASHER, GASKET AND CLAMP OVER BRAID. CLAMP IS INSTALLED SO THAT ITS INNER SHOULDER FITS SQUARELY AGAINST END OF CABLE JACKET.

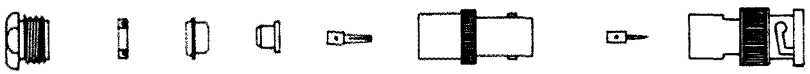
WITH CLAMP IN PLACE, FOLD BRAID BACK AS SHOWN AND TRIM 3/32" FROM END.

SLIP CONTACT IN PLACE, BUTT AGAINST DIELECTRIC AND SOLDER. REMOVE EXCESS SOLDER FROM OUTSIDE CONTACT SURFACE. APPLY MINIMUM HEAT SO DIELECTRIC IS NOT HEATED EXCESSIVELY AND SWOLLEN, PREVENTING ENTRANCE TO CONNECTOR BODY.

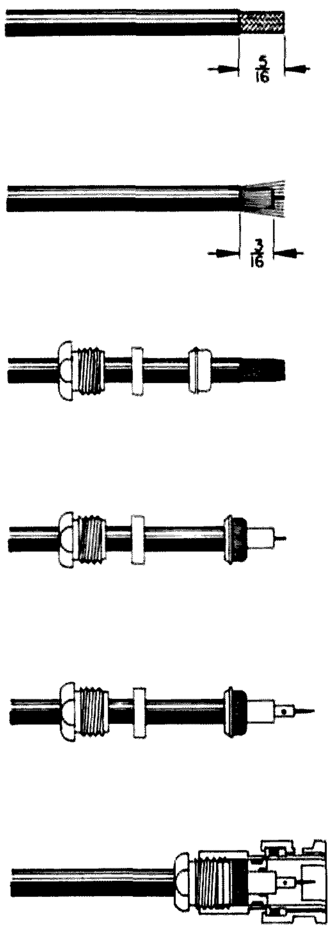
PUSH ASSEMBLY INTO CONNECTOR BODY AS FAR AS IT WILL GO. INSERT NUT, SCREW INTO PLACE AND TIGHTEN WITH WRENCH. HOLD CABLE AND BODY RIGID AND ROTATE NUT DURING THIS OPERATION.

Fig. 20. Assembly of series BNC connectors.

SERIES BNC IMPROVED



*FOR RG-62/U CABLES



CUT END OF CABLE SHARP AND SQUARE. STRIP CABLE JACKET 5/16"

COMB OUT BRAID AND FLARE AS SHOWN. CUT CENTER DIELECTRIC 3/16" FROM EDGE OF JACKET. TIN CENTER CONDUCTOR.

TAPER SHIELD AND SLIDE NUT, GASKET AND CLAMP OVER BRAID. PUSH CLAMP BACK AGAINST JACKET.

WITH CLAMP IN PLACE FOLD BRAID BACK AS SHOWN AND TRIM TO PROPER LENGTH. ADD BUSHING FOR RG-62/U TYPE CABLE.

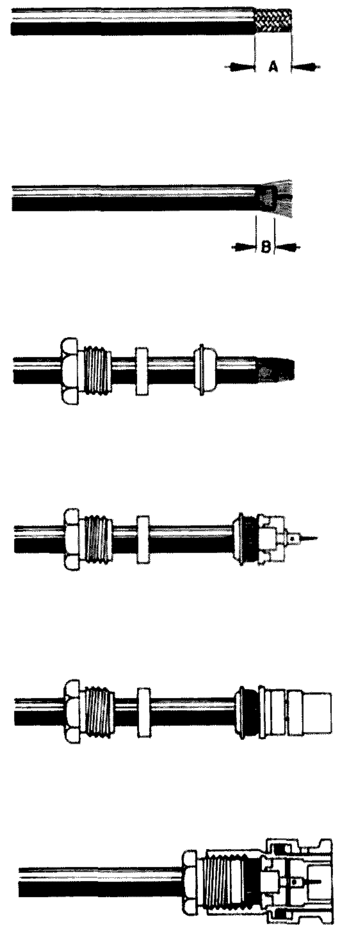
SOLDER CENTER CONDUCTOR TO CONTACT, AVOIDING EXCESSIVE HEAT WHICH MIGHT SWELL CABLE DIELECTRIC.

PUSH ASSEMBLY INTO CONNECTOR BODY AS FAR AS IT WILL GO. MAKE SURE SHARP EDGE OF CLAMP SEATS PROPERLY IN GASKET. TIGHTEN NUT.

Fig. 21. Assembly of series BNC improved connectors.

SERIES BNC WITH CAPTIVATED CONTACTS

*FOR RG-62/U CABLES



STRIP CABLE JACKET TO "A" SHOWN IN CHART BELOW. CUT END OF CABLE SHARP AND SQUARE.

	31-301, 31-304	ALL OTHERS
"A"	27/64"	3/8"

COMB OUT BRAID AND FLARE AS SHOWN. CUT CENTER DIELECTRIC TO DIMENSION "B" SHOWN IN CHART BELOW.

	RG-58/U, 59/U	RG-62/U
"B"	3/16"	5/32"

TAPER SHIELD AND SLIDE NUT, GASKET AND CLAMP OVER BRAID. PUSH CLAMP AGAINST JACKET. TIN CENTER CONDUCTOR.

FOLD BRAID BACK AS SHOWN AND TRIM TO PROPER LENGTH. SLIDE ON BUSHING, REAR INSULATOR AND CONTACT. THESE PARTS MUST BUTT AS SHOWN. SOLDER CONTACT TO CENTER CONDUCTOR. APPLY MINIMUM HEAT SO CENTER DIELECTRIC IS NOT HEATED EXCESSIVELY AND SWOLLEN, THEREBY PREVENTING ENTRANCE TO THE CONNECTOR BODY.

SLIDE FRONT INSULATOR OVER CONTACT AND BUTT AGAINST CONTACT SHOULDER. DO NOT REVERSE DIRECTION OF INSULATOR.

PUSH ASSEMBLY INTO CONNECTOR BODY AS FAR AS IT WILL GO. MAKE SURE SHARP EDGE OF CLAMP SEATS PROPERLY IN GASKET. TIGHTEN NUT.

Fig. 22. Assembly of series BNC connectors with captivated contacts.

Table 9. Coaxial connector index. Charted by cable size and coupling method

Military Number	Series	Description	Type*	For RG/U Cables Type	Amphenol Number	Engineering Data
UG-9/U	N	Plug	S	5	—	
UG-10/U	N	Panel Jack	S	5	—	
UG-11/U	N	Jack	S	5	—	
UG-12/U	N	Jack	S	5	22000	Rexolite Insul.
UG-13/U	N	Panel Jack	S	8	—	
UG-14/U	N	Jack	S	8	—	
UG-15/U	N	Plug	S	5	—	
UG-16/U	N	Panel Jack	S	5	—	
UG-17/U	N	Jack	S	5	—	
UG-18/U	N	Plug	S	5	3400	Not Weather-Proof
UG-18B/U	N	Plug	S	5	82-86	Teflon Insul.
UG-18C/U	N	Plug	I	5	82-203	Teflon Insul.
UG-18D/U	N	Plug	I	5	82-3203	Teflon Insul.
UG-19/U	N	Panel Jack	S	5	3500	Rexolite Insul.
UG-19B/U	N	Panel Jack	S	5	82-87	Teflon Insul.
UG-19C/U	N	Panel Jack	I	5	82-207	Teflon Insul.
UG-19D/U	N	Panel Jack	I	5	82-3207	Teflon Insul.
UG-20/U	N	Jack	S	5	42000	Rexolite Insul.
UG-20B/U	N	Jack	S	5	82-88	Teflon Insul.
UG-20C/U	N	Jack	I	5	82-210	Teflon Insul.
UG-20D/U	N	Jack	I	5	82-3210	Teflon Insul.
UG-21/U	N	Plug	S	8	3900	Rexolite Insul.
UG-21B/U	N	Plug	S	8	82-61	Teflon Insul.
UG-21C/U	N	Plug	S	8	82-96	Teflon Insul.
UG-21D/U	N	Plug	I	8	82-202	Teflon Insul.
UG-21E/U	N	Plug	I	8	82-3202	Teflon Insul.
UG-22A/U	N	Panel Jack	S	8	7500	Rexolite Insul.
UG-22B/U	N	Panel Jack	S	8	82-62	Teflon Insul.
UG-22C/U	N	Panel Jack	S	8	82-95	Teflon Insul.
UG-22D/U	N	Panel Jack	I	8	82-208	Teflon Insul.
UG-22E/U	N	Panel Jack	I	8	82-3208	Teflon Insul.
UG-23/U	N	Jack	S	8	48000	Not Weather-Proof
UG-23A/U	N	Jack	S	8	7600	Rexolite Insul.
UG-23B/U	N	Jack	S	8	82-63	Teflon Insul.
UG-23C/U	N	Jack	S	8	82-94	Teflon Insul.
UG-23D/U	N	Jack	I	8	82-209	Teflon Insul.
UG-23E/U	N	Jack	I	8	82-3209	Teflon Insul.
UG-27A/U	N	Right Angle Adapter	—	—	82-64	
UG-27B/U	N	Right Angle Adapter	—	—	82-98	
UG-27C/U	N	Right Angle Adapter	—	—	82-213	
UG-28A/U	N	Tee Adapter (F-F-F)	—	—	82-99	
UG-29/U	N	Straight Adapter	—	—	15000	Rexolite Insul.
UG-29A/U	N	Straight Adapter	—	—	82-65	Teflon Insul.
UG-29B/U	N	Straight Adapter	—	—	82-101	Teflon Insul.
UG-30/U	N	Bulkhead Adapter (F-F)	—	—	82-66	Rexolite Insul.
UG-30C/U	N	Bulkhead Adapter (F-F)	—	—	82-201	Glass Insul.
UG-30D/U	N	Bulkhead Adapter (F-F)	—	—	91100	Glass Insul.
UG-57/U	N	Straight Adapter (M-M)	—	—	16000	Rexolite Insul.
UG-57A/U	N	Straight Adapter (M-M)	—	—	45250	Teflon Insul.
UG-57B/U	N	Straight Adapter (M-M)	—	—	82-100	Teflon Insul.
UG-58/U	N	Receptacle (70 ohm)	—	—	82-24	
UG-58A/U	N	Receptacle (70 ohm)	—	—	82-97	
UG-73/U	UHF	Plug	—	59	—	
UG-83/U	—	Adapter, N (F) to UHF (M)	—	—	14000	Rexolite/Teflon Insulation
UG-83A/U	—	Adapter, N (F) to UHF (M)	—	—	16150	Rexolite/Bakelite Insul.
UG-83B/U	—	Adapter, N (F) to UHF (M)	—	—	34125	Teflon Insul.
UG-88/U	BNC	Plug	S	58	31-002	
UG-88A/U	BNC	Plug	S	58	14525	
UG-88B/U	BNC	Plug	S	58	31-018	
UG-88C/U	BNC	Plug	I	58	31-202	
UG-88D/U	BNC	Plug	I	58	31-2202	
UG-88E/U	BNC	Plug	I	58	31-3202	
UG-89/U	BNC	Jack	S	58	31-005	
UG-89A/U	BNC	Jack	S	58	31-019	
UG-89B/U	BNC	Jack	I	58	31-205	
UG-89C/U	BNC	Jack	I	58	31-2205	
UG-90/U	BNC	Panel Jack	S	59	1300	
UG-91A/U	N	Plug (70 ohm)	S	6	7200	
UG-92A/U	N	Jack (70 ohm)	S	6	7700	
UG-93A/U	N	Panel Jack (70 ohm)	S	6	7800	
UG-94A/U	N	Plug (70 ohm)	S	11	82-84	
UG-95A/U	N	Jack (70 ohm)	S	11	82-89	
UG-96A/U	N	Panel Jack (70 ohm)	S	11	82-90	

Military Number	Series	Description	Type*	For RG/U Cables Type	Amphenol Number	Engineering Data
UG-106/U	N	Hood	—	—	83-1H	
UG-107/U	N	Tee Adapter (F-M-F)	—	—	4800	Rexolite Insul.
UG-107A/U	N	Tee Adapter (F-M-F)	—	—	82-36	Teflon Insul.
UG-107B/U	N	Tee Adapter (F-M-F)	—	—	82-102	Teflon Insul.
UG-111/U	UHF	Plug	—	59	83-750	Filled Bakelite
UG-146/U	—	Adapter, N (F) to UHF (M)	—	—	4400	Not Weatherproof
UG-159A/U	N	Bulkhead Jack	S	5	17500	
UG-159B/U	N	Bulkhead Jack	I	5	15550	
UG-160A/U	N	Bulkhead Jack	S	8	82-67	
UG-160B/U	N	Bulkhead Jack	S	8	82-93	
UG-160C/U	N	Bulkhead Jack	I	8	—	
UG-160D/U	N	Bulkhead Jack	I	8	91025	
UG-167A/U	N	Plug	S	17	82-104	
UG-171/U	—	Adapter, UHF to British	—	—	—	
UG-173/U	UHF	Reducing Adapter	—	38	—	
UG-175/U	UHF	Reducing Adapter	—	58	83-185	
UG-176/U	UHF	Reducing Adapter	—	59	83-168	
UG-177/U	UHF	Hood	—	58	83-765	
UG-185/U	BNC	Receptacle	—	—	4500	
UG-188/U	N	Plug	S	58	23250	Not Weatherproof
UG-197/U	—	Adapter, UHF to British	—	—	—	
UG-201/U	—	Adapter, N (F) to BNC (M)	—	—	31-830	
UG-201A/U	—	Adapter, N (F) to BNC (M)	—	—	31-216	
UG-202/U	N	Right Angle Adapter (F-F)	—	—	—	
UG-203/U	UHF	Plug	—	59	83-776	Filled Bakelite
UG-204A/U	N	Plug	S	14	82-105	Rexolite Insul.
UG-204C/U	N	Plug	I	14	82-214	Teflon Insul.
UG-223/U	UHF	Bulkhead Receptacle	—	—	—	
UG-224/U	UHF	Bulkhead Adapter (F-F)	—	—	29500	Rexolite Insul.
UG-231/U	N	Receptacle	—	—	2750	With Hood
UG-239/U	UHF	Hood	—	59	—	
UG-253/U	BNC	Bulkhead Jack, Pressurized	—	58	—	
UG-254A/U	BNC	Receptacle, Pressurized	—	—	31-016	Rexolite Insul.
UG-255/U	—	Adapter, BNC (F) to UHF (M)	—	—	2900	
UG-260/U	BNC	Plug	S	59	31-012	Rexolite Insul.
UG-260A/U	BNC	Plug	S	59	31-021	
UG-260B/U	BNC	Plug	I	59	31-212	Teflon Insul.
UG-260C/U	BNC	Plug	I	59	31-221	Beryllium Contacts
UG-261/U	BNC	Jack	S	59	31-015	Rexolite Insul.
UG-261A/U	BNC	Jack	S	59	31-022	Rexolite Insul.
UG-261B/U	BNC	Jack	I	59	31-215	Teflon Insul.
UG-262/U	BNC	Panel Jack	S	59	31-011	Rexolite Insul.
UG-262A/U	BNC	Panel Jack	S	59	31-023	Rexolite Insul.
UG-262B/U	BNC	Panel Jack	I	59	31-211	Teflon Insul.
UG-266/U	UHF	Receptacle, Pressurized	—	—	4575	Rexolite Insul.
UG-273/U	—	Adaptr, BNC (M) to UHF (F)	—	—	31-028	Non-constant Impedance
UG-274/U	BNC	Tee Adapter (F-M-F)	—	—	31-008	Rexolite Insul.
UG-274A/U	BNC	Tee Adapter (F-M-F)	—	—	31-208	Teflon Insul.
UG-281/U	N	Panel Jack	S	58	3525	Rexolite Insul.
UG-282/U	—	Adapter, BNC (M) to Binding Post	—	—	—	
UG-290/U	BNC	Receptacle	—	—	31-003	Rexolite Insul.
UG-290A/U	BNC	Receptacle	—	—	31-203	Teflon Insul.
UG-291/U	BNC	Panel Jack	S	58	31-001	Gold Plated Contacts
UG-291A/U	BNC	Panel Jack	S	58	31-020	Not Weatherproof
UG-291B/U	BNC	Panel Jack	I	58	31-201	
UG-295/U	UHF	Plug	—	8	—	
UG-296/U	UHF	Receptacle	—	8	—	
UG-297/U	UHF	Right Angle Adapter (M-F)	—	—	—	
UG-298/U	UHF	Tee Adapter (F-M-F)	—	—	—	
UG-299/U	UHF	Straight Adapter (F-F)	—	—	—	
UG-299/U	UHF	Straight Adapter (F-F)	—	—	—	
UG-300/U	UHF	Bulkhead Adapter (F-F)	—	—	—	
UG-306/U	BNC	Right Angle Adapter (M-F)	—	—	31-009	
UG-307/U	UHF	Straight Panl Mounting Adapter	—	—	—	
UG-314/U	—	Adapter, N (F) to UHF (M)	—	—	—	
UG-318/U	—	Adapter, N (F) to UHF (F)	—	—	26700	
UG-332/U	—	Adapter, UHF (M) to Binding Post	—	—	5800	Rexolite Insul.

Military Number	Series	Description	Type*	For RG/U Cables Type	Amphenol Number	Engineering Data
UG-335/U	—	Adapter, N (M) to BNC (F)	—	—	3025	Rexolite/Teflon Insulation
UG-349/U	—	Adapter, N (M) to BNC (F)	—	—	2975	Rexolite/Teflon Insulation
UG-349A/U	—	Adapter, N (M) to BNC (F)	—	—	31-217	Teflon Insul.
UG-357/U	UHF	Receptacle	—	34	83-21R	
UG-358/U	UHF	Plug	—	34	83-21SP	Filled Bakelite
UG-360/U	UHF	Straight Adapter (F-F)	—	—	83-21J	Polystyrene Insulation
UG-363/U	UHF	Bulkhead Adapter	—	—	83-1F	Polystyrene Insulation
UG-365/U	BNC	Receptacle	—	—	4650	Turret Terminal
UG-366/U	UHF	Hood	—	—	—	
UG-367/U	N	Receptacle	—	—	—	
UG-372/U	UHF	Hood	—	8	83-1HP	
UG-414/U	BNC	Flanged Feedthrough Adapter (F-F	—	—	47000	
UG-447/U	BNC	Receptacle	—	—	31-817	Rexolite Insul.
UG-464/U	N	Tee Adapter (F-F-M)	—	—	—	
UG-483/U	N	Jack	S	81	14175	Not Weatherproof
UG-484/U	N	Jack	I	82	—	
UG-486/U	N	Plug	I	81	—	
UG-487/U	N	Plug	I	81	—	
UG-491/U	BNC	Straight Adapter (M-M)	—	—	8425	
UG-491A/U	BNC	Straight Adapter (M-M)	—	—	31-218	
UG-492A/U	BNC	Pressurized Bulkhead Adapter (F-F)	—	—	31-220	Glass/Teflon Insulation
UG-492B/U	BNC	Pressurized Bulkhead Adapter (F-F)	—	—	31-2220	Glass/Teflon Insulation
UG-527/U	BNC	Plug	—	100	—	
UG-535/U	BNC	Right Angle Receptacle	—	—	5675	
UG-536/U	N	Plug	S	58	3400	Rexolite Insul.
UG-536B/U	N	Plug	I	58	34025	Teflon Insul.
UG-556/U	N	Bulkhead Jack	S	58	35250	
UG-556A/U	N	Bulkhead Jack	I	58	—	
UG-557/U	N	Plug	S	118	—	
UG-557A/U	N	Plug	I	118	—	
UG-589/U	BNC	Plug	—	—	—	For Single Wire
UG-593/U	N	Panel Jack	S	59	35500	
UG-593A/U	N	Panel Jack	I	59	—	
UG-594A/U	N	Right Angle Jack	I	8	15425	
UG-602/U	N	Jack	S	59	36500	Rexolite Insul.
UG-602A/U	N	Jack	I	59	36525	Teflon Insul.
UG-603/U	N	Plug	S	59	34500	Rexolite Insul.
UG-603A/U	N	Plug	I	59	34525	Teflon Insul.
UG-604/U	BNC	Receptacle	—	—	—	
UG-606/U	—	Adapter, N (M) to BNC (M)	—	—	—	
UG-624/U	BNC	Bulkhead Jack	S	59	2075	Rexolite Insul.
UG-625/U	BNC	Receptacle	—	—	5575	Rexolite Insul.
UG-625B/U	BNC	Receptacle	—	—	31-236	Teflon Insul.
UG-646/U	UHF	Right Angle Adapter (M-F)	—	—	83-1AP	Polystyrene Insulation
UG-657/U	BNC	Pressurized Receptacle	—	—	31-102	Rexolite Insul.
UG-680/U	N	Receptacle	—	—	82-811	Glass/Teflon Insulation
UG-909/U	BNC	Bulkhead Jack	S	58	31-206	½" Thread Mounting
UG-909B/U	BNC	Bulkhead Jack	I	58	—	½" Thread Mounting
UG-910/U	BNC	Bulkhead Jack	S	59	31-207	
UG-910B/U	BNC	Bulkhead Jack	I	59	—	
UG-911A/U	BNC	Pressurized Receptacle	—	—	31-237	Glass/Teflon Insulation
UG-912/U	BNC	Pressurized Receptacle	—	—	31-238	
UG-913/U	BNC	Right Angle Plug	S	58	31-204	
UG-913A/U	BNC	Right Angle Plug	I	58	—	
UG-914/U	BNC	Feedthrough Adapter (F-F)	—	—	31-219	
UG-928/U	BNC	Receptacle	—	—	1100	Rexolite Insul.
UG-935A/U	N	Panel Jack	I	10	82-211	
UG-936A/U	N	Bulkhead Jack	I	8	16250	
UG-940A/U	N	Jack	I	8	82-212	Armor Clamping
UG-941A/U	N	Plug	I	8	82-204	Armor Clamping
UG-959/U	BNC	Plug	S	8	6775	
UG-959A/U	BNC	Plug	I	8	—	
UG-978/U	—	Adapter, BNC to Banana Jack	—	—	—	
UG-982/U	N	Plug	I	17	92125	Armor Clamping
UG-987/U	—	Adapter, BNC to two Male Banana Plugs	—	—	8975	
UG-997A/U	N	Right Angle Receptacle	—	—	84975	
UG-1003/U	N	Plug	S	63	12400	Armor Clamping

Military Number	Series	Description	Type*	For RG/U Cables Type	Amphenol Number	Engineering Data
UG-1006/U	N	Plug	I	74	—	
UG-1017/U	—	Adapter, UHF to Banana Jack	—	—	—	
UG-1018/U	N	Straight Adapter	—	—	—	
UG-1033/U	BNC	Plug	I	122	84975	
UG-1034/U	—	Adapter, BNC (F) to N (F)	—	—	5225	
UG-1052/U	N	Panel Jack	I	58	36000	Rexolite Insul.
UG-1055/U	BNC	Panel Jack	I	122	84625	
UG-1056/U	BNC	Jack	I	122	84650	
UG-1082/U	BNC	Plug	I	122	—	
UG-1094/U	BNC	Receptacle	—	—	31-221	
UG-1095A/U	N	Panel Jack	I	58	36250	
UG-1098/U	BNC	Right Angle Receptacle	—	—	31222	
UG-1104/U	BNC	Male Receptacle	—	—	—	
UG-1174/U	BNC	Right Angle Receptacle	—	—	38425	
UG-1185/U	N	Plug	CC	8	82-312	
UG-1185A/U	N	Plug	CC	8	82-3312	
UG-1186/U	N	Jack	CC	8	82-313	
UG-1187/U	N	Panel Jack	CC	8	82-314	
UG-1195/U	N	Plug	CC	18	—	
MX-367	BNC	Hood	—	59	10925	
MX-539	UHF	Hood	—	58	5375	
MX-543	UHF	Hood	—	8	5475	
MX-913	N	Cap and Chain (M)	—	—	82-106	
MX-195A	BNC	Hood	—	58	87175	
PL-258	UHF	Straight Adapter (F-F)	—	—	83-1J	
PL-259	UHF	Plug	—	8	83-1SP	Filled Bakelite
PL-259	UHF	Plug	—	8	83-822	Teflon Insul.
PL-259A	UHF	Plug (Clamp set screw)	—	8	83-1SPN	Mica Filled
PL-259A	UHF	Plug (Clamp set screw)	—	8	83-756	Teflon Insul.
PL-274	UHF	Bulkhead Adapter (F-F)	—	—	83-1F	
SO-239	UHF	Receptacle	—	—	83-1R	Mica Filled
SO-239	UHF	Receptacle	—	—	83-1RTY	Polystyrene
SO-239A	UHF	Receptacle	—	—	83-798	Teflon Insul.

Corrections

After the July issue went to press, we received some interesting comments on our FET articles from one of the engineers at Siliconix (manufacturer of the U-112 and U-110 field effect transistors).

1. In K3CLU's Field Effect Voltmeter on page 34, the values of R16 and R17 should be set so that there is −6 volts on the drains of the FET's and +3 volts at point F. In addition, to improve linearity, R10 and R14 should be changed to 5 k, R12 to 5 k or 10 k and R13 should be eliminated entirely.
2. In K3CLU's Transistor Analyzer on page 30, the voltmeter circuit may not operate properly with **all** 2N2498's. If the device ie near the center of the spread in operating characteristics, it will work fine; if not, the completed unit may exhibit poor linearity.
3. The Audio Compressor by K3VNR may operate somewhat better if a U-112 or U-148 is used for Q4. Also, C7 does not have to be as large as that shown in the schematic if R9 and R10 are increased to maintain the same time constant.

Caveat Emptor?

★ Price—$2 per 25 words for non-commercial ads; $5 per 25 words for business ventures. No display ads or agency discount. Include your check with order.

★ Type copy. Phrase and punctuate exactly as you wish it to appear. No all-capital ads.

★ We will be the judge of suiability of ads. Our responsibility for errors extends only to printing a correct ad in a later issue.

★ For $1 extra we can maintain a reply box for you.

★ We cannot check into each advertiser, so Caveat Emptor . . .

ALL MAKES of new and used amateur equipment. Write or call Bob Grimes, 89 Aspen Road, Swampscott, Mass. Tel: 617-598-9700 or 617-598-2530.

CONVERTERS. World's largest selection of frequencies. Ham TV vidicon cameras and parts at low factory-direct prices. See them all now in our full page ad in this issue. Vanguard Labs, 196-23 Jamaica Ave., Hollis, N.Y. 11423.

WE WILL PAY CASH: Wanted, popular, late model unmodified amateur equipment. Highest prices paid for clean, good operating gear. Write Graham Radio, Dept. 10, Reading, Massachusetts.

ARE YOU SINCERE? Are you **really** looking for the best deal on a new or fully guaranteed used unit? Let us convince you with a specific quote that will **really** save you money. Graham Radio, Dept. 10, Reading, Massachusetts.

BUILD W1JJL's popular CPO-CWM (code practice oscillator-CW monitor) from the July 1965 73, page 32. The predrilled board with component locations silk-screened on it is only 50¢. The board with all parts mounted on the board is $3 and the unit assembled in an attractive case is a remarkable $7.95. Order today from the Harris Co., 56 E. Main St., Torrington, Conn.

25 WORDS FOR $2. Sell or buy through these want ads, a terrific bargain. Caveat Emptor, 73 Magazine, Peterborough, N. H. 03458.

COMMUNICATIONS RECEIVERS—an excellent booklet from the RSGB. Limited number available for only 50¢ 73 Magazine, Peterborough, N. H. 03458. each.

NOVICE AND TECHNICIAN HANDBOOK by W6SAI and W6TNS. Limited quantity for only $2.50 each. 73 Magazine, Peterborough, N. H. 03458.

SELLING OUT. NCX-3, NCX-D, Heath AC P/s, used 10 hours, best offer over $340. Apache (needs $13 xformer) $94. Ranger I, $98. Computer test P/S (good for parts) $8.50. Selectric typewriter keyboard for that code machine project, $15. PMR6A receiver & 12 VDC supply (used but electrically very good) $65. Perfect AC supply for PMR6A, $40; both $90. Send S.A.S.E. to Jim Beistle, 3728 Wilkie Way, Ft. Worth, Texas.

HALLICRAFTERS SX101A $215, HT32A $290, HT32 $270, SX62A $110, excellent shape, just factory reconditioned; still in sealed cartons with receipts. No price compromise and you must pay shipping. Joe K9VAR, 1851 North Rutherford, Chicago, Illinois 60635.

MARK III RF IMPEDANCE Bridge, reprinted from August '61 73 Magazine; excellent article plus 13 enlarged diagrams available for $1. 73 Magazine, Peterborough, N.H. 03458.

WANTED: Topcon Super D camera, Topcor lenses, or any accessories. Cash or will trade QST/CQ collection, lab test equipment, or electronic parts. Box 55, c/o 73 Magazine, Peterborough, N.H. 03458.

WANTED GOLDKIT THRILLER transceiver. Box 211, Wilmington, N.C.

PHASEMASTER II 160-10 meter phasing type SSB exciter. 75 watts PEP; unit complete with Band-Hopper VFO. Unit is in good condx, only $100. 73 Magazine, Peterborough, N.H. 03458.

GERMAN OM looks for "Hints and Kinks" to modify an SP 600 JX (military model). BRUNS, Bielitzerstr. 8, 8000 Munich 55, Germany.

NC 303 GOOD CONDX, must sell for college expenses, $165 here or $175 shipped. Wes Canfield WA4EPB/Ø, 2325 Carpenter, Des Moines, Iowa 50311.

YORK COUNTY HAMFEST. The 11th Annual Hamfest will be held Sept. 4 on the Adams County Fair Grounds, 4 mi north of Abbottstown, Pa. Registration starts at 9 AM. Talk-ins on 145.62 and 50.62 mc. Xmtr hunt, games, free drawings, auction. Write K3POR, 170 S. Albemarle St., York, Pa.

SURPLUS HANDBOOK Volume I, covering receivers and transceivers; just a few available at $3 each. 73 Magazine, Peterborough, N.H. 03458.

QSL CARDS???? Made-to-order!! Samples 25¢ Sakkers, W8DED, Holland, Michigan 49423. (mention 73).

SONAR 80-10 METERS TRANSMITTER with matching VFO; uses efficient 5894 in the final. $100 with power supply. 73 Magazine, Peterborough, N.H. 03458.

2 METER SPECIAL. Narrowband hiband base station, 30 watt Bendix in good shape $59. Now on 160 mc—send self-addressed envelope for listing. All sales FOB Ft. Worth, Texas 76100.

CANADIANS—New Bud deluxe cabinet 21x13x15 deep. Partially completed transmitter to fit; 814 tube; 19 set; Hammond 762 plate transformer; CQ's-QST's 58-61. Sell any best offer. VE7CT, 3636 West 17th Ave., Vancouver 8.

BROADCAST STATION FOR SALE. 250 watt Gates never unpacked, or share in station after intensive investigation. Gene Markos K9JFE Litchfield, Illinois. 324-3178 after 6 PM.

SIX ASSORTED ISSUES of ATV Experimenter, circa '64-'65, $1 from 73 Magazine, Peterborough, N.H. 03458.

WANTED: Link power amplifier type 1908 with tubes. Advise price, condition. W8ACP, 960 W. Milton, Alliance, Ohio

CQ-QST. CQ 1948-1960, 118 issues; QST 1953-1960, 64 issues. Either or both to highest bidder. K5DZM, 1112 Bellaire, Grapevine, Texas.

DELAWARE HAMFEST. The amateur radio clubs of Delaware have joined together to put on the 1966 Delaware Hamfest in Wilmington, Delaware on August 14. For more info contact Bill Robinson K3UHU, 204 W. Delaware Ave., Wilmington 19809.

SCHEMATICS FOR either the ARC-508, or the ARR 15, both described in June '65 issue of 73, only 50¢ each. 73 Magazine, Peterborough, N.H. 03458.

CHRISTIAN HAM FELLOWSHIP now being organized for tract, missionary and fellowship among Christian hams. Donations for the work appreciated. Christian Ham Callbook $1 donation. Send for free details from Christian Ham Fellowship, Box 218, Holland, Michigan 49423.

NEW

COLLINS MECHANICAL FILTERS—E 445D-31, 455 KC center frequency, 6 db bandwidth 3.1 KC, 60db bandwidth 6.5 KC. New $54.00. Our price $19.50

NATIONAL MB 40SL Multi-Band Tank. 3.2 to 9.0 mc and 12.0 to 34.0 mc for grid circuits of 20W input and final plate circuits with 40 W input. $3.95

TELEX RELAY—115 VAC, 60 cy, 20 ma "Half Wave" 3/8" silver contacts, Berylium copper springs, DPDT.
$2.00—with diode $2.25

Build yourself a simple six and two meter Amplifier 250W, for less than the price of a new 4CX250B—Ours are pullouts but guaranteed good and we only have a few of these tubes left in stock. All we're asking is ...... $10.00 each

Government Warehouse, Inc.
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Red Bank, New Jersey 07701

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EVERYTHING UNCONDITIONALLY GUARANTEED!

PROFESSIONAL HI-FI CONDENSER MICROPHONE
Brand new $114.85 capsule only, but we include dwg of Paramount Picture's cathode-follower preamp using only 3 batteries, 3 resistors, 3 capacitors, 1 #5718 tube. Mnfr's specs: "±1 db from DC 12½ kc, usable beyond 25 kc; 25 pf; −75 db across 10 meg load for 10 bar signal at 180 v polarizing; will work past 170 dbm; will stand 200 G shock." Undirectional. Size: Will fit in 2-1/16" circle; 7/8" thick OA. **WHILE THEY LAST.** Postpaid, only 27.50

KEEP LINE VOLTS CONSTANT AUTOMATICALLY
These Regulators, **ALL AT LOW SURPLUS BARGAIN PRICES,** hold output at 115/120 v despite line changes 95-130 v and load changes 0 to full load. **CV:** Tuned saturating isolating transformers hold to 1%, have 14% harmonics. **EM:** Servo, hold to 1%. ZERO harmon. **S EI:** Electronic, hold to 0.1%, 3% max. harm. Sola, Sorensen, Superior Electric.

CV:	250 VA	$ 22.50	500 VA	$ 37.50
	1 KVA	69.50	2 KVA (230v)	99.50
S/EI:	500 VA	99.50	5 KVA (230v) ..	350.00
	2 KVA *	129.50	1 KVA	129.50
	2½ KVA *	199.50	2 KVA	199.50
*Items are special values			3 KVA	279.50
10 KVA				595.00

EM: 6 KVA, $279.50 (Incl. Gen Radio 1570AL)
EMT (transistorized) 28 KVA 230V 350.00

ALL-BAND SSB RCVR BARGAIN: Hallicrafters R-45/ARR-7, 550 kc to 43 mc continuous. Voice, CW, MCW, aligned, grtd. W/book; 2-RF, 2-IF's. S-meter; noise lmtr; 3 xtl, 3 non-xtl selectivity choices.
Less pwr sply 149.50
60 cy pwr sply: $30. SSB product detector: $20

TIME PAY PLAN: Any purchase totaling $160.00 or more, down payment only 10%

DZ-1 superhet rcvr 15-70 & 100-1500 kc.	89.50
RAK-7 TRF rcvr w/pwr sply 15-600 kc.	99.50
RBL-5 TRF rcvr 15-600 kc built-in pwr	125.00
R-23/ARC-5 Command rcvr 190-550 kc.	14.95
A.R.C. 12 #22 Command rcvr 540-1600 kc.	17.95
RBS 14-tube superhet 2-20 mc w/pwr sply	69.50
ARR-5 rcvr, 60 cy, am/fm, 27-140 mc.	149.50
APR-4Y AM/FM Rcvr mod. to 115 v 50/60 cy, with pwr plug, book, tuners 38-1000 mc.	250.00
P.U.R. for tuners 975-2200 and 2175-4000 mc.	
RA-62-B is AC pwr sply for SCR-522, only	17.95
FRC-6A 50 w xmtr 30-40 mc FM, 60 cy pwr	69.50
TDQ 45 w xmtr 2 meter A2, A3, 60 cy pwr	295.00
TDZ 30 w xmtr 225-400 mc brand new	P.U.R.
TCM is AC pwr sply suitable for ART-13	79.50
LM-14 freq. meter, .01% 125 kc-20 mc.	57.50
TS-323/UR freq. meter 20-480 mc., .001%	169.50

OTHER MATERIAL: Hewl-Pack & Tekt. Scopes, 30 types of Signal Generators, Gertsch material, Bridges, VLF Receivers, Noise/Field-Strength Meters, DVM's, etc. etc. **WRITE! WE ALSO BUY!**

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Phone: Area 213, office 272-5707, messages 275-5347

DRAKE 2-B $170. Bud low pass filter $5. Lafayette phone patch $12. Dow-Key relay $5. Dr. Marvin Lee, 5219 Nichol Ave., Anderson, Indiana 46011.

RELIABLE SSB EXCITER, the Phasemaster Jr., produces 60 watts PEP; phasing type of sideband generation. $75. 73 Magazine, Peterborough, N.H. 03458.

SURPLUS PARTS salvaged from power supply including: voltage regulator 0-130 volts. Write Philip Hunrath, 47 Parker Pl., Shrewsbury, N.J. 07704.

HT 33B, EXCELLENT CONDX. Tube practically new. Asking $425. H. J. Nadley, W3INH, 307 Woods Road, Glenside, Pa. 19038. Day phone 215-LO3-5579.

PEORIA HAMFEST September 18, Peoria, Illinois, Peoria Area Amateur Radio Club, advance registration $1.50. Write Ferrel Lytle, W9DHE, Stonegate Road, Peoria, Illinois 61614.

BARGAINS! Transmitters, Receivers, Test Equipment offered, wanted in ham's trading paper. Next 12 interesting issues $1. Sample copy free. "Equipment Exchange-Ham Trader", Sycamore, Illinois.

INTERESTED IN VHF? Flexible converter covers 6, 2, and 1¼ meters; it's made for the NC-300, but is useable with any receiver covering 30-35 MC. $50. 73 Magazine, Peterborough, N.H. 03458.

80 METER crystal controlled converter to BC band. 12 volt, just plug into antenna lead and connect to battery lead. $5 delivered. Jack Morgan WØRA, Greenfield, N.H. 03047.

WANTED case for Morrow receiver. WA1CCH, c/o 73, Peterborough, N.H. 03458.

NEW 55 AMP DELCO-REMY alternators with matching regulators; $37.50 per set. R. F. Bevington, Blytheville, Ark.

COMPLETE CONVERSION instructions for the AN/VRC-2, just $1 while the supply lasts. 73 Magazine, Peterborough, N. H. 03458.

TELETYPE SYSTEM-Perforator with keyboard $69. Distributor transmitter (reads and sends tape) $35. Printer perforator (no motor) $25. Distributor for sync. $15. First come, first served any or all. Jack Fisher 579 Royalton Dr., New Haven, Ind. 46774.

AUDIO FILTERS 300 cycle to 3600 cycle passband. 500 ohms in, 10K out, 15 watt max. FB for phone patch, inverted audio SSB, A.F. Q5er. Unused surplus commercial units $2.50 each postpaid. Lock City Electric, P.O. Box O, Freeland, Mich. 48623.

SURPRISE PACKAGE—For only one dollar you receive a goody box of electronic parts worth many times above price. Quaker Electronics, P. O. Box 215, Hunlock Creek, Pa. 18621.

WANTED 3CX2500, 3CX10,000/8159, 4CX10,000/8171 power transmitting tubes, used TV and commercial pullouts. Price must be reasonable. Bill Smitherman WA4YFC, Rt. 2, East Bend, N. Carolina.

HX30 HEATHKIT SSB 6 transmitter, new $140. Clegg Zeus modulator power supply $325. Interceptor $200. Globe High Bander $65 and Globe Chief $65. Hammarlund 100AC receiver. Smitty K1BWX, 81 Lenox Ave., Providence, R. I.

WANTED TELETYPE EQUIPMENT, especially model 28. Cash or trade for new amateur equipment. Alltronics-Howard Co. Box 19, Boston, Mass. 617-742-0048.

6288 FEET HIGH for 6 & 2 DX on Mt. Washington, N.H. Take your gear on Cog RR from base station. Food and facilities available at Summit House, also bunks for overnight.

DETAILED CONVERSION instructions for a surplus two meter transceiver similar to Bendix MRT-9. 50¢ each from 73, Peterborough, N.H. 03458.

CALL LETTER BILLFOLDS—Handtooled—Men's economy $6.50, Ladies or Men's Deluxe $8.00, Keycases $3.50, prepaid. Jane Freestone, WAØEHS, P. O. Box 82, Peru, N.Y. 12972.

LONG ISLAND HAMFEST & PICNIC sponsored by the Federation of Long Island Radio Clubs will be held Sunday July 17th. at 9AM. COME ON DOWN with the entire family for a pleasant day. Picnic pavilions, Swimming, Playgrounds, Charcoal grills, Technical talks, Manufacturers displays, Prizes, Mobile judging contest, Auction and more.

SCHOOL CLUB would appreciate your old Handbooks, code records, crystals, other small gear; 73's, QST's, even CQ's. W50PX Nolan High School, Fort Worth, Texas. 76103.

SCHEMATIC DIAGRAM for ARC 27 GUARD RECEIVER only 50¢, as offered in June '66 issue. 73 Magazine, Peterborough, N. H. 03458.

TWO METERS $48.00. Over fifty-five dollar value Heathkit Twoer and Ameco nuvistor preamp. Both new—in excellent condition. Arthur Karis 14 Caldwell St., Fitchburg, Mass.

WANT: Kilowatt Matchbox. Virgil Talbott, W6GTE 1175 Longhill Way, Monterey Park, Calif. 91754 AN-88868

WANTED: Military, Commercial, Surplus. Airborne, Ground, Transmitters, Receivers, Testsets, Accessories. Especially COLLINS. We pay Freight and Cash. RITCO POB 156, Annandale, Virginia 22003 (703) 560-5480 COLLECT.

WRL's BLUEBOOK SAVES YOU MONEY. Take these prices without trades! KWM-2—$675.00; 30L1—$341.00; G50—$197.10; HT37—$242.10; SX99—$89.10; SX101A—$188.10; SR150—$341.10; HW12—$107.10; AF67—$44.95; King 500A—$233.10; HQ110—$120.60; R4—$269.10; Galaxy 300—$161.10. Hundreds more—free list. WRL, Box 919, Council Bluffs, Iowa 51501.

PROVEN PERFORMERS both of them, the DX-35 and DX-20 are good Novice CW transmitters. DX-35 $25, and DX-20 just $20. 73 Magazine, Peterborough, N.H. 03458.

SX 101-3-A—matching speaker $150.00 pick up only. Martin Rexsen W2FEI 493 Oxford Road, Cedarhurst, N.Y. 11516. Tel. 516-Ce 9-2411.

FOR SALE: Collins 32S-3, 75S-3B with 200 cy and 4 kc filters, 30L-1, 312B-4, and 516F-2 without cabinet. Excellent condition. Best offer over $1,650.00. Jim Taylor, W8EEC, 23874 Oak Lane, North Olmstead, Ohio.

TOROIDS, 88mh uncased, 5/$2.50. RTTY Filters, pretuned and mounted on tiny printed circuit board, with socket $4.25 ea. Humphrey WA6FKN Box 34, Dixon, California 95620

SWAN 350 with calibrator and 117XC power supply. Both purchased new 1-15-66. Sell both for $400. Bob Gaskill. 2105 Arthur. Wichita Falls, Texas.

ANTENNAS AND HIGH POWER! 40 foot 2-section crank-up tower with TR-44A rotator, cables, coax, triband quad: $100. 14AVS: $15. Heath SWR bridge: $7. 7 foot deluxe rack cabinet, KW supplies, 3KV silicon bridge, linear amplifier, monitor scope, station control system, transistorized keyer, 24-hour clock, A.M. components, reconditioned Messiner "Signal Shifter" VFO, and much more: inquire and offer. J. D. Kronman, 14612 Hamlin St., Van Nuys, California 91401 Tel: (213) 786-7663.

NATIONAL NC-270 Excellent, $135—HallicraftersHT-18 VFO exciter $30, GE 12 volt, two piece FM, 52.525 MHz complete, $55—AN/VRC2 FM, rcvr converted, xmtr part converted to 6m, with Motorola control head, $40—4ES-12A3 12 volt 2m FM, no acc $35—BC-459, converted to 6&2 VFO, $10. All FOB Pontiac, Michigan. Charley, K8LKV, 359 Grand Traverse, West; Union Lake, Michigan.

BACK ISSUES

Back Issue Bonanza

Curl up in your hammock these hot days with twenty assorted fascinating back issues of 73. They'll keep your mind, imagination and soldering iron active through the sweltering weather. Our choice (but a good one) at this low price. 20 issues for $5.

Dottie's Special

Get eight fabulous back issues of our choice for only $2.

Single Back Issues

Individual back issues other than 1960 ones are 50¢. 1960 issues cost $1. January 1961 isn't available.

Bound Volumes

All we've got right now are 1963 bound volumes. They're beautiful and cost $15.

Binders

Binders for all years are available: 1960-61, 1962, 1963, 1964, 1965 and 1966. They're $3 apiece and a nuisance to wrap, so order a bunch at once, please.

All of the offers above are postpaid in the U.S.A. and Canada. Please include postage on overseas orders.

73 Magazine Peterborough, N.H. 03458

INDEX TO ADVERTISERS

Propagation Chart

AUGUST 1966

J. H. Nelson

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	7	7	7	7	7	7*	14	14	14	14
ARGENTINA	21	14	14	14	7	7	14	21	21	21*	21*	21*
AUSTRALIA	14*	14	7#	7#	7	7	7	14	7#	7#	14	14*
CANAL ZONE	21	14	14	7*	7	7	14	14	21	21	21*	21
ENGLAND	7*	7	7	7	7	7*	14	14	14	14	14*	14
HAWAII	14	14	7*	7	7	7	7	7#	14	14	14	14
INDIA	7*	7#	7#	7#	7#	7#	14	14	14	14	14	14
JAPAN	14	14	7#	7#	7#	7#	7*	7*	7	7#	14	14
MEXICO	14	14	7	7	7	7	14	14	14	14	14*	14*
PHILIPPINES	14	14	7#	7#	7#	7#	7*	7*	7*	14	14#	14
PUERTO RICO	14	7*	7	7	7	7	14	14	14	14	14	14
SOUTH AFRICA	14	7	7	7#	7#	14	14	14	21	21*	21	14
U. S. S. R.	7	7	7	7	7	7#	14	14	14	14	14	7#
WEST COAST	21	14	14	7	7	7	7*	14	14	14	14*	14*

CENTRAL UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	14	7	7	7	7	7*	14	14	14	14
ARGENTINA	21	14	14	14	7	7	14	21	21	21	21*	21*
AUSTRALIA	21	14	14	7#	7#	7	7	14	7#	7#	14	21
CANAL ZONE	21	14	14	14	7	7	14	14	21	21	21	21*
ENGLAND	7#	7	7	7	7	7	14	14	14	14	14	14
HAWAII	14*	14	14	7	7	7	7	7#	14	14	14	14
INDIA	7*	7*	7#	7#	7#	7#	7#	7#	14	14	14	14
JAPAN	14	14	14	7#	7#	7#	7	7*	7*	7#	14	14
MEXICO	14	14	7	7	7	7	7	14	14	14	14	14
PHILIPPINES	14	14	14	7#	7#	7#	7#	7*	7*	14	14#	14
PUERTO RICO	14	14	7*	7	7	7	14	14	14	21	21	21
SOUTH AFRICA	14	14	7	7#	7#	14	14	14	14*	14*	14*	14
U. S. S. R.	7#	7	7	7	7	7#	7#	14	14	14	14	7#

WESTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	14	14	7	7	7	7	14	14	14	14
ARGENTINA	21*	21	14	14	14	7	7#	14	21	21	21*	21*
AUSTRALIA	21*	21*	21	14	14	14	7	7	7	7#	14	21*
CANAL ZONE	21*	14	14	7*	7	7	7	14	14	21	21*	21*
ENGLAND	7#	7#	7	7	7	7	7#	14	14	14	14	14
HAWAII	21*	21	21	14	7*	7	7	7	14	14	21	21
INDIA	14	14	14	7#	7#	7#	7#	7#	7*	14	14	14
JAPAN	14*	14	14	14	7*	7	7	7	14	14	14	14
MEXICO	14	14	7	7	7	7	7	7*	14	14	14	14
PHILIPPINES	14*	14*	14	14	14	7	7	7	14	14	14#	14
PUERTO RICO	21	14	14	7*	7	7	7*	14	14	21	21	21
SOUTH AFRICA	14	7	7	7#	7#	7#	7#	14	14	14	14*	14*
U. S. S. R.	7#	7#	7	7	7	7#	7#	14	14	14	14	7#
EAST COAST	21	14	14	7	7	7	7*	14	14	14	14*	14*

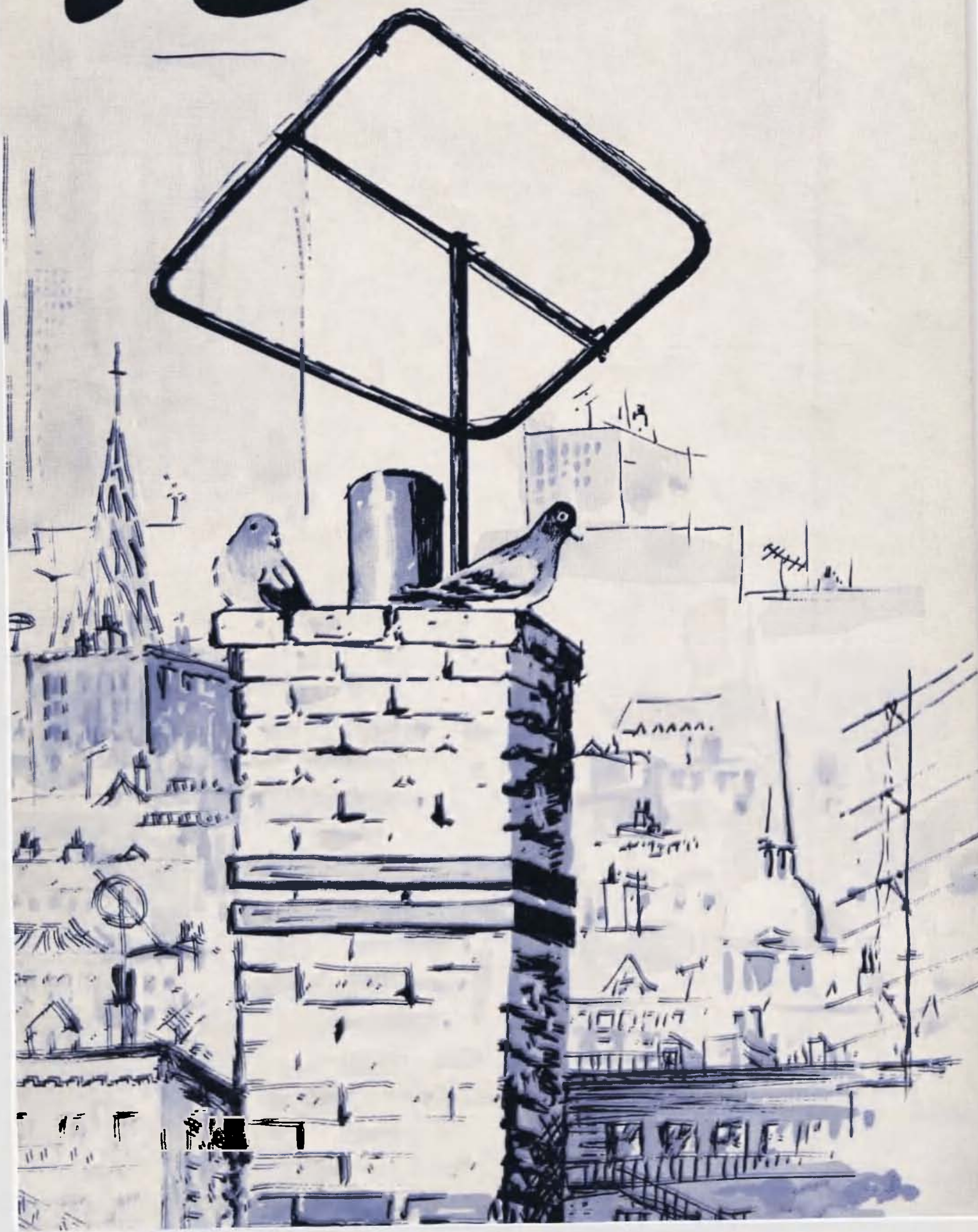
Very difficult circuit this hour.
* Next higher frequency may be useful this hour.

Good: 1, 3-9, 15-20, 23, 24, 30, 31
Fair: 11-13, 22, 27-29
Poor: 2, 10, 14, 21, 25, 26
VHF DX: 6-9, 15-18, 28-31

73 Amateur Radio

SEPTEMBER 1966

60¢? Certainly!



73 Magazine

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September 1966

Vol. XLII, No. 1

Our cover this month is by Sidney Willis of Bennington, N.H. Sid is a well-known artist who specializes in still lifes of objects associated with Old New England; he has won a number of gold medals at N.E. Art Shows.

SPECIAL BOOK FEATURE

73 Magazine is published monthly by 73, Inc., Peterborough, N. H. 03458. The phone is 603-924-3873. Subscription rates $4.00 per year, $7.00 two years, $10 three years world wide. Second class postage is paid at Peterborough, New Hampshire and at additional mailing offices. Printed in Bristol, Conn., U.S.A. Entire contents copyright 1966 by 73, Inc. Postmasters, please send form 3579 to 73 Magazine, Peterborough, New Hampshire. Why not make a DX friend of yours happy with a gift subscription to 73?

de W2NSD/1

never say die

First WTW Winner

The first complete collection of QSL's for the Worked the World Certificate was received here in Peterborough July 8. Cdr. Gay Milius W4NJF of Norfolk, Virginia sent in 104 good cards to be the first winner. Gay is a Legal Officer at the U.S. Naval Station in Norfolk; he has an AB from Dartmouth and LLB from Fordham. Gay has written a number of articles for ham magazines, and, as the photo shows, is an avid DX'er.

Who's going to be next?

ET3AC system

One of the problems facing all DXpeditions, and for that matter, just about all rare DX stations, is how to go about working the maximum number of stations in a minimum amount of time. Those of you who chase DX know only too well how terrible some of the stations do at this art form.

Our more experienced DXpeditioners have got the business fairly streamlined. Don Miller cranks out one or two contacts a minute for hours on end. Gus does likewise. Don and Gus use split frequencies. They usually operate down around 14100 kHz on sideband and then listen from 14200 up for calls. This works

Gay Milius W4NJF, winner of the first WTW award.

pretty fast, but they do have to sit and wait for each caller they hear to stop sending before they can work him. Most savvy DXers make their calls short, but now and then you run across an idiot that spells out his call four times and you wonder if he is ever going to shut up.

When you are transceiving on your own frequency the pileup problem can be devilish. Some DX stations find they have to wait several minutes before fellows stop calling them long enough to let anyone hear them come back. This only happens when the DX station lets the situation get out of control. I've had good success on my own frequency from rare spots by standing by for short calls from specific areas and using fast break-in. I can usually keep up with Don and Gus in contacts per hour using this system.

The other day I heard Blake, ET3AC, using a new idea while he was knocking them off from FL8AC. The idea seems like a good one to me and I'd like to pass it along because I think it has possibilities for working even more stations per given time than those we've been using. Blake would announce that he was going to tune a band of frequencies for given time and write down all the calls he heard. He would then look for the fellows on his own frequency with fast break-in. This spread out all of the calling stations over a ten or twenty kilocycle band so he could get their calls easily, and this is the hardest part of the contacts. He knocked off two to three a minute average this way.

Some rare DX operators complain that they get mobbed every time they come on the air by all the fellows who want a QSL card. Sure they do . . . because they haven't taken the few days it takes to work the several thousand DXers. If they would just devote a few days to working stations as fast as they can and get the services of a QSL manager they would be able to operate with little interference in the future.

It *is* possible to take the heat off by working all the DXers. We have several countries with just one or two stations, but which are not considered rare by any means. I've operated from 4U1ITU many times and it is so common even though it is the only station in the "country" that I frequently have to call CQ a couple of times to get a contact from there. To perk up interest in this station they had to run through some new prefixes (4U2ITU, etc.).

And let's just have a word on QSL's. They are a heck of a lot of trouble, as I know only

(Continued on page 80)

Editor's Ramblings

Paul Franson WA1CCH

Abbreviations—again

I've been very surprised at the smallness of the uproar over our adopting the modern *hertz* for the older term, *cycles per second.* We've only received three letters so far, and two of them end with the clever pun, " . . . it **hertz.**"

The tables on this page list the rest of the relevant abbreviations for units from the international system adopted by the NBS, the IEEE, and many U.S. magazines—including 73. Most of the changes are minor, and serve mostly to avoid the inconsistencies of the older system: *m* means *milli, micro* and *mega* in *mh, mf* and *mc* as used by older magazines. Nevertheless, some of them look a bit peculiar at first, though not as bad as *Hz.* In a few years, we'll be so used to the newer system that the old abbreviations will look as odd as the old schematics in *Radio* or pre-war QSTs. Here are some of the abbreviations we normally use:

capacitance: pF, μF
current: μA, mA, A
frequency: Hz, kHz, MHz
inductance: μH, mH, H
power: μW, mW, W, kW
power gain: dB
resistance or impedance: Ω, kΩ, MΩ
time: ms, s
voltage: μV, mV, V, kV

Some of the units are rarely used in electronics, of course. Many of the prefixes are also rare: *tera* is almost unknown; *giga* is used only in gigahertz; *hecto* and *deka* aren't used; *deci* is used only in *decibel* and *centi* in *centimeter; nanofarad* (.001 μF or 1000 pF) is used in continental Europe but not often in the U.S.; *femto* and *atto* aren't used in radio—at least by hams.

Many possible combinations of prefixes and units are not used or are rarely used. Here are some surprises:

MC: megacoulomb
μS: microsiemens (micromho)
mF: millifarad (1000 μF)
MF: megafarad (1,000,000,000 μF)
MA: megaampere (1,000,000 ampere)

Confused? You needn't be. The whole system is straightforward and easy to understand after a few minutes' study.

. . . WA1CCH

Abbreviations for Basic Units

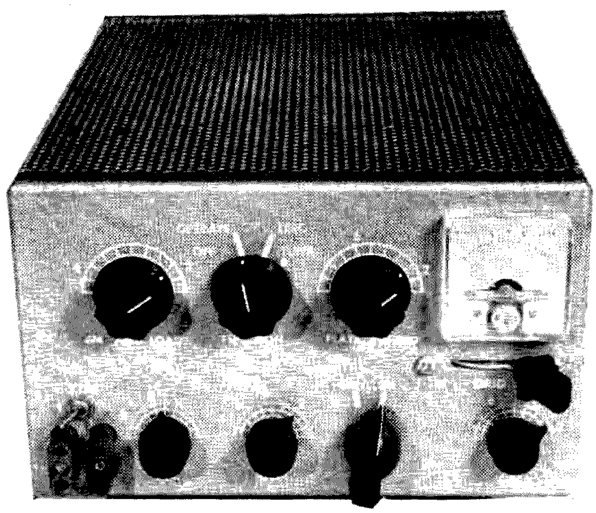
Name	Quantity	Abbreviation
ampere	current	A
bel	gain, loss	B
coulomb	charge	C
farad	capacitance	F
henry	inductance	H
hertz (old cps)	frequency	Hz
joule	work, energy	J
meter	length	m
ohm	resistance	Ω
second	time	s
siemens (old mho)	conductance	S
volt	voltage	V
watt	power	W
weber	magnetic flux	Wb

Note that abbreviations for units derived from proper names are capitalized. Other units such as hour and foot can also be used, of course. Liter and ampere-hour are units of capacity, but the farad is the unit of capacitance.

Prefixes Used with Basic Units

Name	Abbreviation	Multiply by
tera	T	10^{12} or 1,000,000,000,000
giga	G	10^{9} or 1,000,000,000
mega	M	10^{6} or 1,000,000
kilo	k	10^{3} or 1,000
hecto	h	10^{2} or 100
deka	da	10
deci	d	10^{-1} or 1/10 or .1
centi	c	10^{-2} or 1/100 or .01
milli	m	10^{-3} or .001
micro	μ	10^{-6} or .000 001
nano	n	10^{-9} or .000 000 001
pico	p	10^{-12} or .000 000 000 001
femto	f	10^{-15} or .000 000 000 000 001
atto	a	10^{-18} or .000 000 000 000 000 001

Some prefixes are capitalized and some small. The distinction is important. Not all of the prefixes are used in electronics.



Del Crowell K6RIL
1674 Morgan Street
Mountain View, Cal.

A Compact Transmitter for Six and Two

Here's one of the cleverest, simplest and most effective two-band VHF transmitters we've seen. Wouldn't you like one?

Many VHF operators have, at one time or other, had the urge to have a signal with punch. After looking through many issues of magazines and handbooks, I noticed there is very little information published on band-switching VHF transmitters. This inspired me to design this compact transmitter, in which changing bands and retuning can be done in very few minutes. Using 600 volts on the final the power output is approximately 60 watts on 2 and 70 watts on 6.

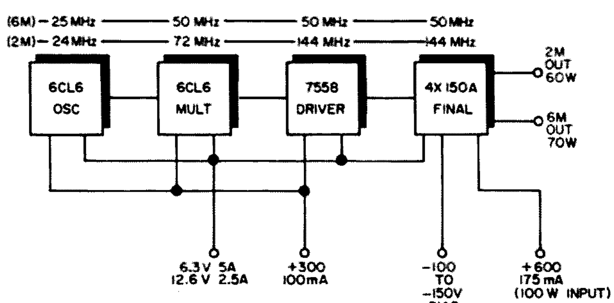


Fig. 1. Block diagram of the simple six and two meter band-switching transmitter with 60 watts output.

This article covers the rf section only. The power supply and modulation is left up to the builder.

Circuit description

The circuit is a simple but very effective design using the following tube lineup: A 6CL6 oscillator (VI) uses crystals in the 8-9 or 24-27 MHz range and the plate tunes from 23.5 to 27 MHz. Next a 6CL6 multiplier (V-2) either doubles to 50 MHz or triples to 72 MHz. The plate is tuned to 72 MHz on 2 meters and on 6 meters a shunt capacitor C9 is switched in to tune the 50 MHz range. The drive uses a 7558 as a straight thru amplifier on 6 meters, or as a doubler on 2 meters, because of loss of driving power on 2 meters the screen voltage on V2 and V3 is increased by shorting out a 27 k resistor R-11 with the bandswitch. This increases the driving power to obtain satisfactory final grid drive. The 7558 uses an unusual tank circuit which has two resonances. On 6 meters, one half of L3 and L4 is resonant at 50 MHz and on 2 meters L3 is resonant at 144 MHz, with L4 acting as an rf choke. C-15 is adjusted so that at 50 MHz the capacitance is near maximum and at 144

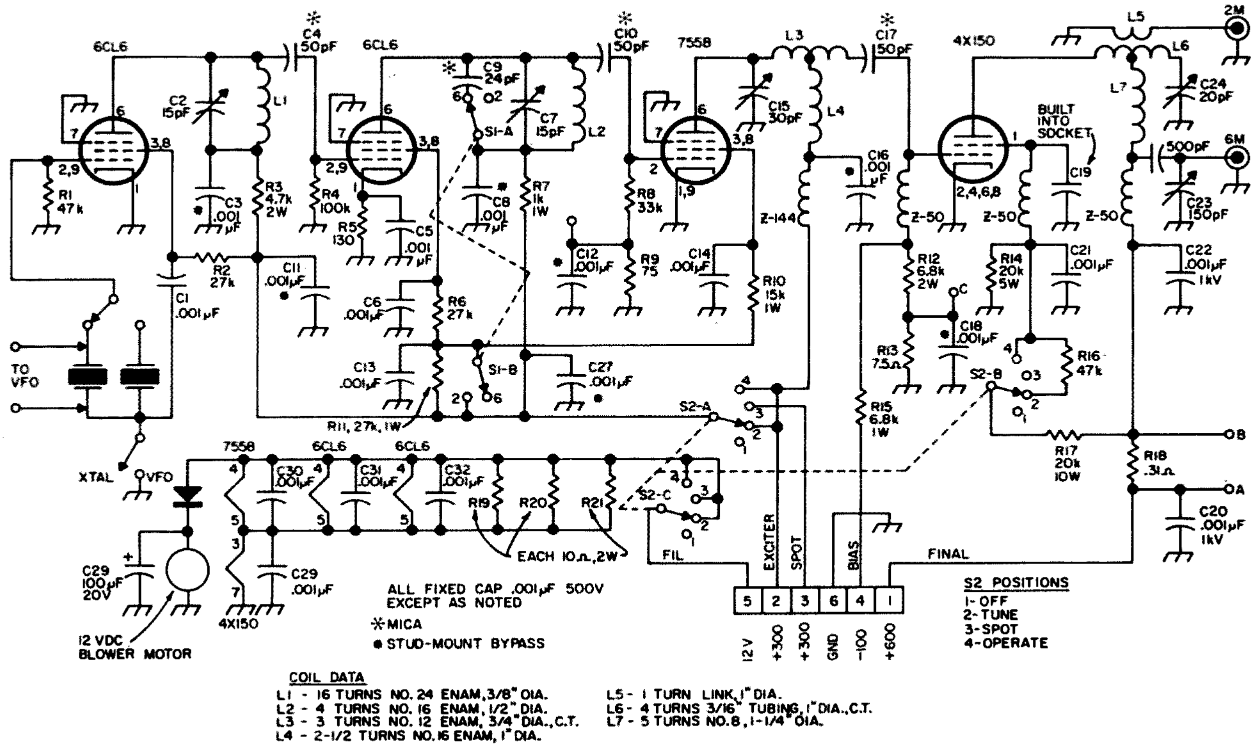
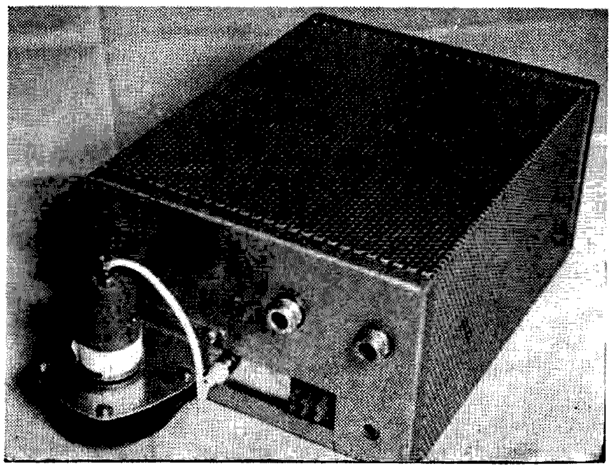


Fig. 2. Schematic of K6RIL's bandswitching six and two meter transmitter. Output from the 4X150A with about 100 watts input at 600 volts is about 60 watts. For metering, see Fig. 3.

MHz C-15 is near minimum. This prevents the resonances from becoming harmonically related, as example, while tuned to 50 MHz the 144 tank will tune near 130 MHz.

The 4X150A performs very nicely as the final amplifier. By using low plate voltage the tube requires a small amount of air flow to cool. Any small fan which will move air thru the socket and fins would do very well, (be sure to use the chimney). The final operates in class C service and requires at least 8 mA of grid current for plate modulation. The tank circuit L6 and L7 is similar to the one described for V3 (7558), operates as a link coupled output on 2 meters with L7 acting as the rf choke. On 6 meters the tank operates as a pi network output, providing separate outputs for 2 meters and 6 meters, again the tank should be adjusted with C-24 at minimum capacitance for 2 meters and maximum for 6 meters. C-23 adjusts the pi network loading for the 6 meter output. On 2 meters the link is inserted about half way for optimum coupling.

If plate modulation is used the screen must be modulated approximately 30% in phase with the plate. Screen voltage is obtained by a resistive divider from the plate supply. Adjusting the screen voltage to less than 200V will allow about 25% increase on modulation peaks. With



Back view of the transmitter showing the small blower, power receptacle, and the output jacks.

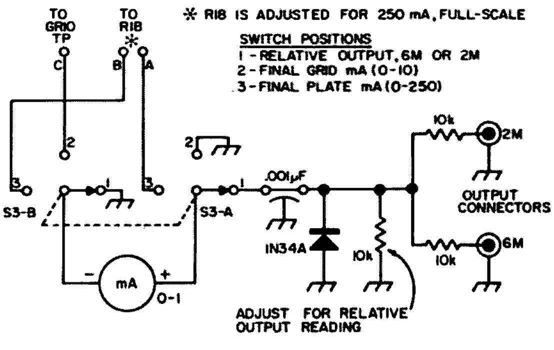
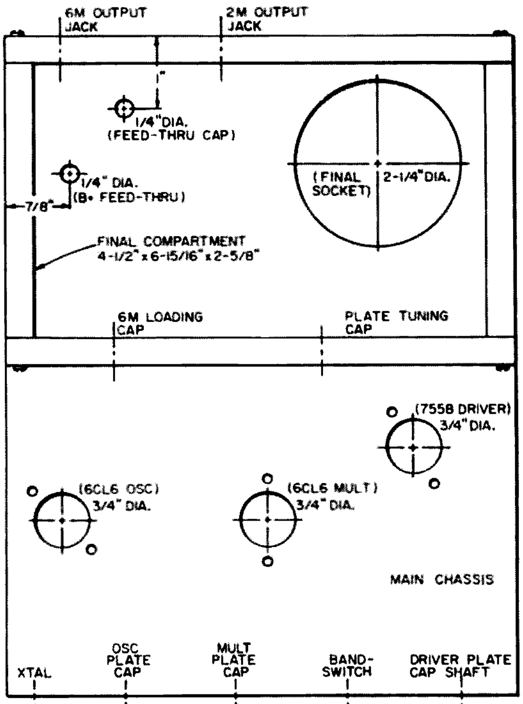
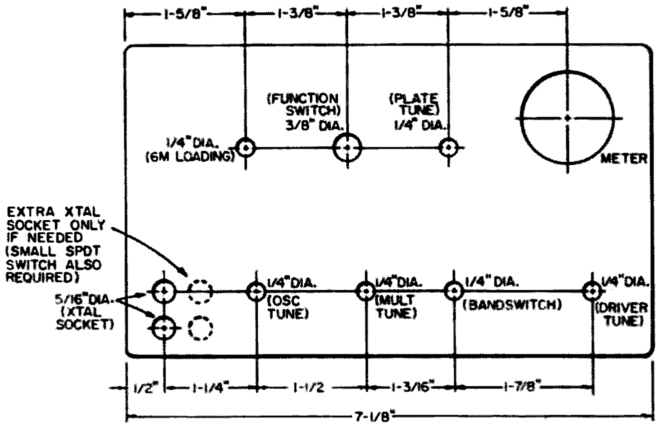


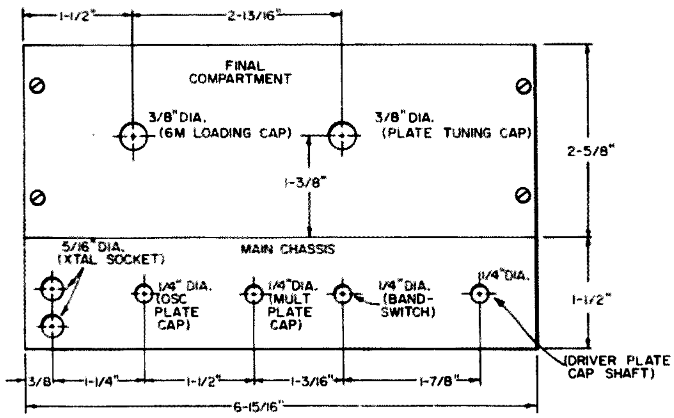
Fig. 3. Metering circuit for the six and two transmitter.



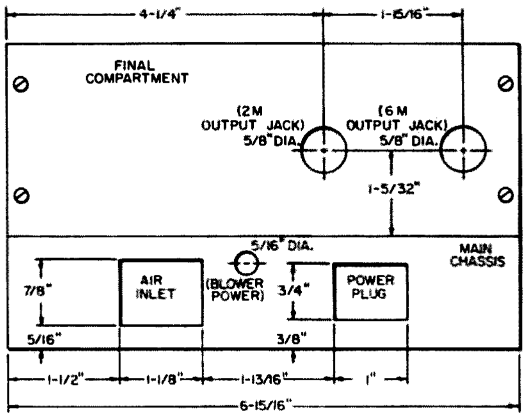
TOP VIEW OF CHASSIS



FRONT PANEL LAYOUT



FRONT VIEW OF CHASSIS



REAR VIEW OF CHASSIS

Fig. 4. Layout of the six and two transmitter. These drawings are one-third full size. Cabinet used is a California Chassis Company LTC-436. See comments at end of article for some modifications.

this method the 4X150A shows very good stability, using 600 V B at 170 mA and screen voltage of 200 V at 10 mA the transmitter delivers approximately 60 watts at 2 meters and 70 watts at 6 meters with close to 100% modulation, the modulator should be capable of 50 watts or more. This transmitter has been used mobile with a transistor power supply and transistor modulator similar to the one in 1962 ARRL Handbook (page 478) with very nice results. The blower used for cooling was a small dc motor and squirrel cage blower operating from the 12 volt battery.

Construction details

The chassis and cabinet shown in pictures is a ready made unit by California Chassis Co., Lynwood, Calif., model LTC436, measures 4⅝" H x 7¼" W x 9¼" D. Final tank compartment was fabricated from 1/16" aluminum and measures 4⅝" x 6 15/16" x 2⅝". A perforated cover allows air to escape but shields the rf. The bottom cover is made from 1/16" aluminum and seals the under side of the chassis to provide a pressurized compartment to cool the 4X150A. A homemade gasket seals between the blower and the chassis.

6 and 2 Meter Transmitter Operating Voltages

	Osc		Mult		Driver		Final	
	6CL6-V1		6CL6-V2		7558-V3		4X150A-V4	
	2M	6M	2M	6M	2M	6M	2M	6M
Plate mA	15	15					170	175
Screen V	160	170	170	150	210	195	210	215
Screen mA	1.2	1.2	3.0	4.5	4.0	3.5	9.2	9.0
Grid V	—37	—37	—50	—70	—40	—42	—90	—95
Grid mA	.7	.7	.5	.7	1.25	1.35	13	14
Supply V	280	280	280	280	280	280	600	600
Plate V	190	200	240	260	270	250	600	600
Power output							60W	70W

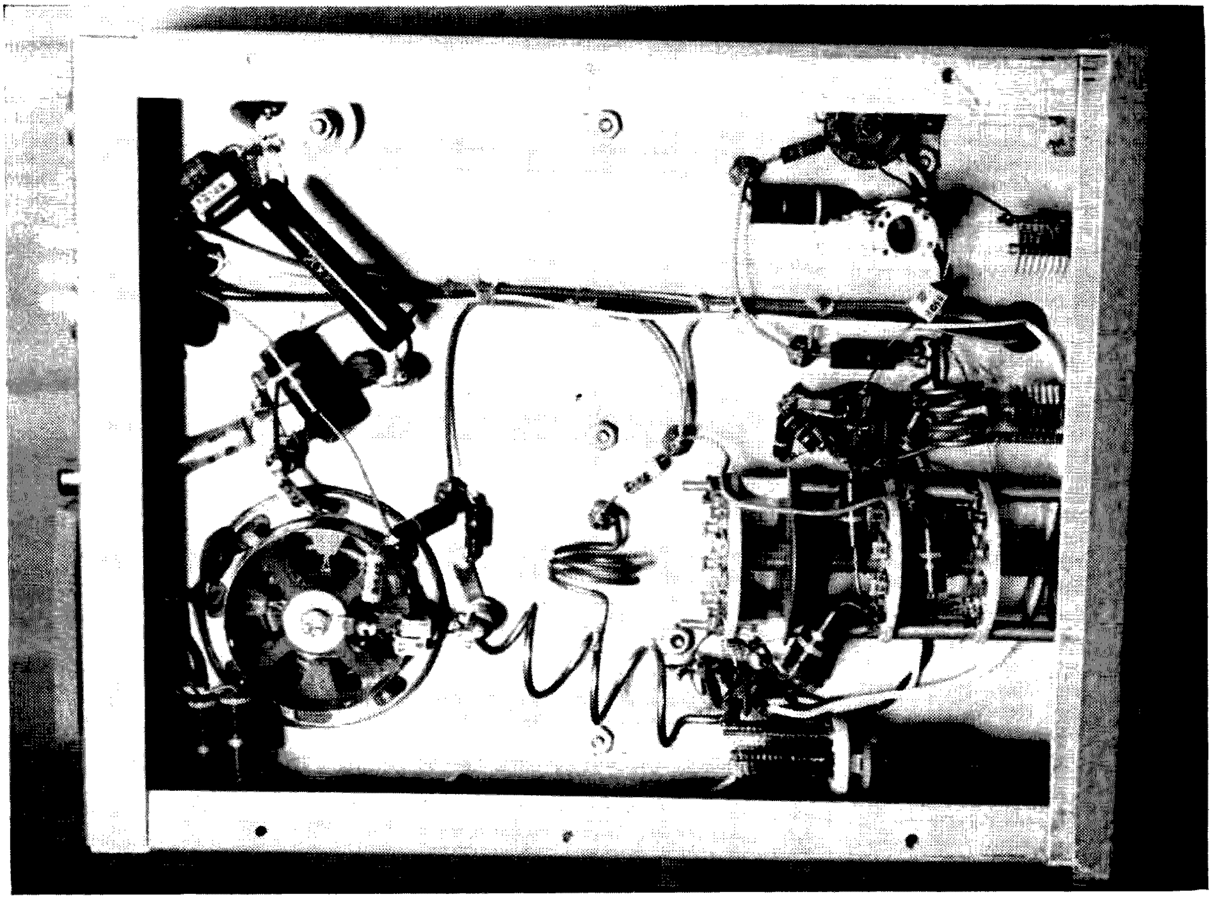
Although the circuit shows the heaters wired for 12 V operation the builder may do as he chooses.

Voltages required are as follows 6 V at 5 Amps or 12 V at 2.5 amps and + 300 V at 100 mA for exciter section and + 500 to + 800 volts at 200 mA and — 130 V bias for final. Originally the final was wired for self bias but for mobile operation proved to be troublesome and fixed bias for protection was added later.

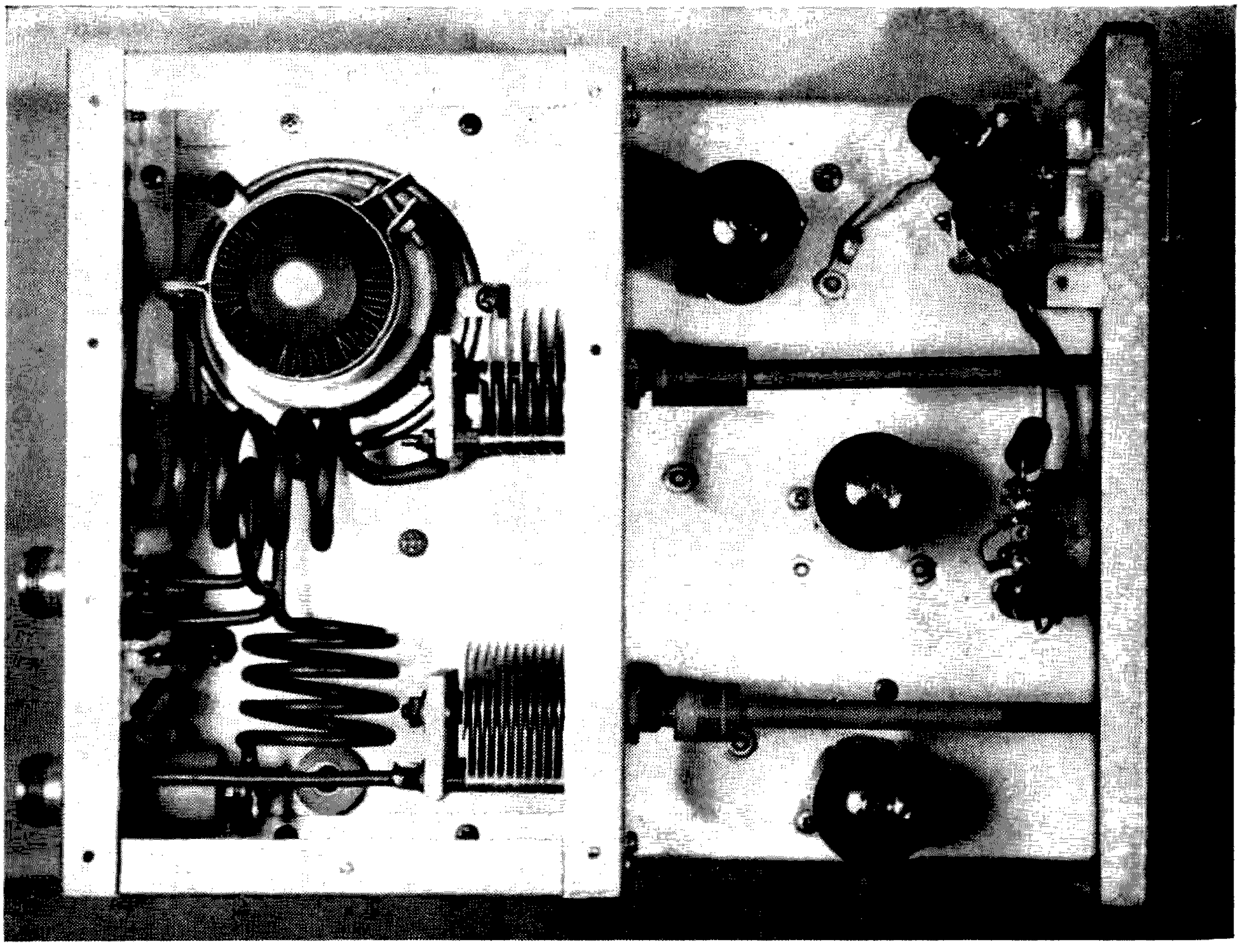
As shown in pictures the controls are marked with the proper positions for both bands as this simplifies changing bands. The panel meter monitors final grid current, plate current and relative rf output. The chart shows the approximate readings for all tubes while tuned and operating on each band.

Power supply and modulator used can be any one of the units constructed from the many handbooks available on the subject. This is left up to the builder depending on the type of operation he desires.

This transmitter has proved to be very enjoyable for over two years of mobile operation. Crystal control was originally used and for the last 1½ years a transistor VFO to be described in 73 has given very good results. The transmitter has also been used in a fixed station with equal results. It won second place



Bottom view of the transmitter showing the two-band grid circuit of the 4X150A. It is very similar to the final plate tank. Note how simple and clean the circuit is, especially when you realize that only two poles of that bandswitch are used. Note that the chassis must be sealed for cooling.



Top of K6RIL's transmitter. The right side contains the three exciter stages and the left the 4X150A final. The final tank is a clever two band circuit. On two, the coil next to the tube acts as a "series" tuned coil resonant at about 146 MHz and the coil below it acts as an rf choke. The six meter loading capacitor has very little affect on two. The two meter output is from a link in the coil. On six, the two meter coil acts as a connection to the pi network tank used for tuning.

in the homebrew contest at ARRL Convention July 1965 at San Jose, Calif.

Using this transmitter has brought great pleasure and many compliments from other stations.

. . . K6RIL

Editor's note: I couldn't resist the simplicity of this transmitter, so built myself one. Of course, I made some changes. John Boyd WAØAYP bent me a nice case and chassis the same size as the one K6RIL used. I made the bottom row of controls on the panel symmetrical by using a smaller band switch and a five-position switch for crystal-VFO switching instead of the panel sockets. A 5763 worked as a driver, but I imagine the 7558 would be better. I found that the 4X150A grid circuit tuned to both 72 and 144 MHz at once, so I added a 72 MHz series tuned trap there to prevent radiating some strong competition for channels 4 and 5. You could probably avoid this by fiddling with the tank instead of the trap. Instead of the socket recommended, I used a surplus one without a bypass, and the homemade bypass I used wasn't quite good enough, so I'd suggest that you use a good Johnson socket. . . WA1CCH.

James Dillman K4USK
P.O. Box 4159
St. Petersburg, Fla.

Poorboy Mark II Quad

Here's an easy-to-handle three band quad made from inexpensive aluminum tubing.

As a result of the article in January, 1964 QST indicating that the cubical quad is the top choice among DX'ers, a renewed interest in this proven performer has been generated on the ham bands.

Many of you yearn to try the quad and have searched hopefully for a design worth investigation.

About the second paragraph of the usual quad article, the words "Take it to your friendly neighborhood welder . . ." leap up from the page to strike you where it hurts. Your neighborhood welder isn't so friendly—he charges, and how!! Besides, did you ever try to explain a "gizmo" that you understood perfectly to someone who didn't? So you get discouraged but still you read on . . .

A couple of paragraphs further down appears the word "bamboo," followed by more words telling you to take tape and wrap every cotton-picking inch of all that bamboo so the weather can't get at it quite so quickly. Let's see: 100′ of bamboo. That means X hundred feet of tape, times Y number of hours wrapping time. Then after that comes . . . ah, heck!

Or, possibly the author urges: "Use wood dowel to join two pieces of EMT to form the crossarms." Dowel is cheap. So is EMT. But, wait! Wood isn't very strong, is it? And, didn't someone tell you that EMT was the stuff that skilled metallurgists developed especially so that it could be easily bent? Remember the time you tried to "unbend" a piece of tubing?

Shucks, you say, it just isn't worth it. Besides, this guy says that the element lengths and the length of the boom are entirely different from the last article you read.

Take heart, OM, and read on about the Poorboy MK II, a quad that will solve all your problems—a tri-band quad made of aluminum tubing, light enough to be handled by a TV rotor, of simplest construction, weatherproof and at a cost of about two-thirds that of a commercial quad made of conventional bamboo.

With this quad, there is no "machine-shop" type work to be done, no welding, no special tools and, except for the tubing, no parts that cannot be obtained at your nearest TV wholesaler, or your neighborhood hardware dealer, etc.

The unique construction design of this quad eliminates the usual bugaboos normally found in the building and raising of the conventional quad. Its two-piece boom eliminates the necessity of having to turn it over on the ground. It can be hoisted into final operating position, one section at a time, by one man.

The Poorboy MK II has been in use at this QTH for five years, using an inexpensive TV rotor on a 30′ slip-up mast and has survived the 90 mph winds of Hurricane Donna and, on two occasions, winds in excess of 70 mph. In addition, it has withstood winds in the 40-50 mph range which are fairly common locally. It is still in perfect alignment and recent examination disclosed that revarnishing of the wood parts was the only item needing attention.

Investigation of Bill Orr's handbook, *Quad Antennas* shows that the gain of a quad is almost constant with spacings from .1 to .2 wavelength between the driven element and the reflector. Further invetsigation shows that the impedance values in this range of spacings

---

Jim is a printer for the Tampa Tribune-Times.

vary from 60 to 110 ohms at an antenna height of ½ wavelength. Arithmetic shows that .1 at 14 MHz is .15 at 21 MHz and .2 at 28 MHz.

The .1 and .15 spacings give impedances of about 60 and 75 ohms which are right smack in the middle of the ball park. But the .2 spacing gives an impedance of about 110 which is somewhat out in left field. The 28 MHz antenna could be fed with 93 or 125 ohm coax. However, in order to use the more readily available 72 ohm coax, an impedance value of about 90 ohms is obtained by the use of 7½" TV stand-off insulators on both the driven element and the reflector which reduces the element spacing at 28 MHz.

Further arithmetic at these spacings gives a boom length of 7'1" but the boom is cut to 7'9" to allow for mounting of the crossarms and a slight bowing effect.

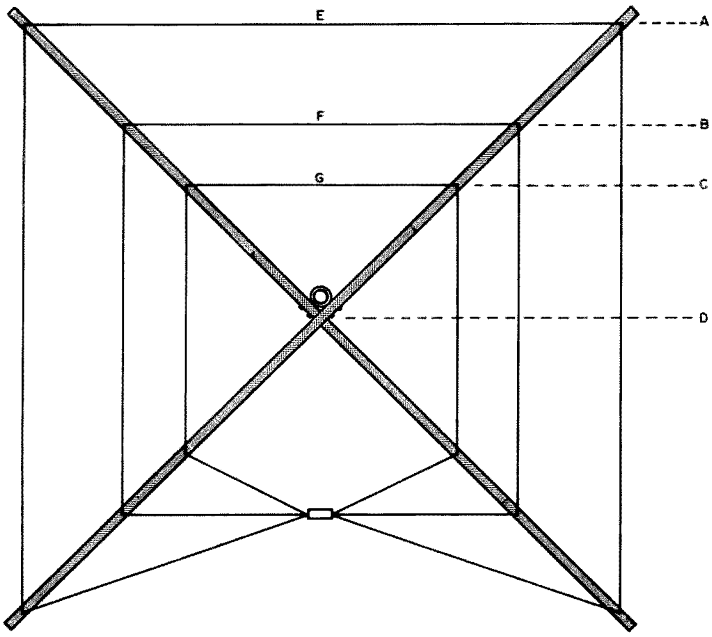
The heart of the Poorboy MK II is the boom which is made from two 5-foot sections of standard 1¼" galvanized TV mast (flared for stacking) joined into a single 10-foot length. Cut the boom 7'9" long, locating the center of the joint 1' from the center of the boom. This is to facilitate mounting to the boom clamp. Locate the large part of the joint on the short side of the boom. The driven elements are built on this short section so that any desired changes may be made by lowering only the driven elements. Minor changes to the reflectors can be made by repositioning the tuning stubs.

Drill a small hole through the joint and insert a steel bolt to insure exact realignment of the boom during assembly. The hole should be barely large enough to accommodate the bolt as insurance against the two sections slipping out of alignment at any time.

The boom clamp is simplicity itself and quite possibly you can scrounge up the materials at no cost to the XYL. Cut a piece of plywood at least ⅝" thick into an 8" square. Fasten an 8" square of galvanized sheet metal (about 18 gauge) on one side of the plywood with several small wood screws.

Use two U-bolt type TV mast clamps with serrated yokes to mount the boom diagonally across the wood side of the boom clamp with the TV clamps as near the corners as possible. Mount the metal side of the boom clamp to the mast with another identical pair of TV mast clamps. Use metal straps similar to those furnished with ordinary U-bolts to lock down on the wood side. Run the mast through the two remaining corners of the boom clamp with one TV clamp at the bottom corner and the second just far enough above the boom to insure clearance. Cut off the tip of the boom clamp above the top mast clamp.

Tubing designated 6061-T6 is generally considered to be an excellent choice for purposes as described here. This is based on economy, strength, corrosion resistance and general availability. Tubing generally comes in 12' lengths but try to get the ¾" in an 18' length which is sometimes available. Use .049 wall



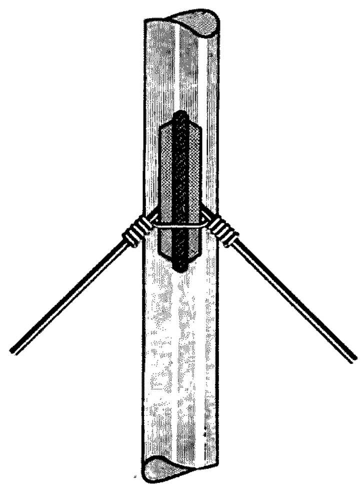


Fig. 1. Left: Arrangement of driven elements when using single feedline. Note boom above point where arms cross. Dimensions are: AD 12'6", BD 8'4", CD 6'2", E 17'8", F 11'9", G 8'7". Right: Exploded view of TV mast clamps used to secure center section of boom and stand-off insulator to tubing.

if possible. It may be difficult to obtain ⅝" and ½" in anything heavier than .035 which can be used as tip sections with no problems. If it must be used as inner sections, it will be necessary to shim up the inside tube. This is not recommended. Going to larger diameter tubing would be preferable.

Each crossarm is constructed from five sections:

A. One center section of ¾" .049 wall tubing, 4½' long.

B. Two inner sections of ⅝" .049 wall tubing, 6' long.

C. Two tip sections of ½" .049 or .035 wall tubing, 6' long.

The inner and tip sections are telescoped about 1' to provide a total length of 24½'. A 1' length of ⅜" wood dowel is inserted 6" into each tip section. These serve as insulators for the 20M elements.

Cut a slot 8" long into both ends of the ¾" tubing and one end of the inner sections. Cut a slot 4" long in one end of each tip section. Remove all burrs inside and out with a file. Sand 6" of the dowel until it slides easily into the tip sections. Drill a hole in the dowel 3" from the metal, just large enough to accept the wire easily. Drill two or three small holes in the tip sections as near as possible to the inner end of the dowel to prevent moisture buildup inside the arms.

Drilling the holes to accommodate the TV mast clamps which hold the center sections of the arms to the boom is the only part of construction requiring special care. It would be prudent to practice on pieces of scrap to drill holes straight through the tubing. A drill press is best, but with care it can be done with a hand drill. Be sure holes are perpendicular to the tubing. The diameter of the holes should only be large enough to insure 90 degree alignment of the arms to the boom. Locate the holes in the middle of the center sections.

Join the two sections of boom and secure with bolt.

Clamp a center section loosely to each end of the boom. To align these sections, place four small blocks of wood of identical thickness under the ends on a flat surface. With a large square borrowed from your friendly neighborhood carpenter, make sure center sections are exactly perpendicular to the boom. Carefully secure the clamps but avoid crushing the boom or tubing. Use clamps with contoured bar under the nuts. These bars can be made from scraps of tubing if they do not come with the clamps.

Once these two sections are aligned, place the ends on something high enough so that the remaining center sections will clear the flat surface an inch or so when in the vertical position. Here is where the XYL can help. Borrow her kitchen chairs. Use blocks of wood and, if necessary, QSL cards to make sure the previously aligned sections and the boom are exactly horizontal by means of a spirit level. The longer the better.

Place the inner center sections about ¼" inside the outer sections. Adjust the inner sections exactly vertical in all planes with the level. Cross check by placing the inner sections on the chairs and use the level to see if the outer sections are vertical.

Clamps for the slotted ends of the tubing are of the garden hose variety. Note: The sizes marked on the clamps are for the INSIDE diameter of the hose. Use two clamps at each joint except the tips where only one is necessary to secure the dowel.

Insulators for the 10 M and 15 M elements are the common 7½" and 3½" stand-off strap variety used for holding a single TV lead clear of the mast. Get those with the V-ends made of solid, flat metal.

With a light hammer, carefully tap both sides of the V narrow enough to rest on the tubing. Place the V on the tubing and run the strap through the slots. Tighten the shaft enough to get a light fit on the tubing. Release the shaft and run the strap around the tubing a second time and repeat the process. You should have a snug, but not tight fit.

With regard to the lengths of the elements, there are almost as many figures available as there are articles written about it. In addition, the usual modifying factors of location, height, construction, etc., enter into the overall picture as with any antenna.

Through the years since the advent of the first quad, the unrealistic claims and confusing dimension figures have jelled down to more conservative claims and a fairly accurate table of dimensions. Bear in mind, always, that stated element dimensions of any antenna are merely typical or average. However, unless something drastic enters the picture, the completed antenna will usually be sufficiently close to its optimum operating condition that tuning adjustments are a simple matter.

It is suggested that you make generous use of a grid-dip meter. The construction of this quad lends itself very well to easy changes of element lengths. The driven elements must be resonant at the design frequency before proper tuning adjustments can be made. Unless this condition is met, no setting of the tuning stubs will produce maximum gain, F/B or minimum SWR. The reflector elements are duplicates of the driven elements with tuning stubs added.

The performance curves of a two-element

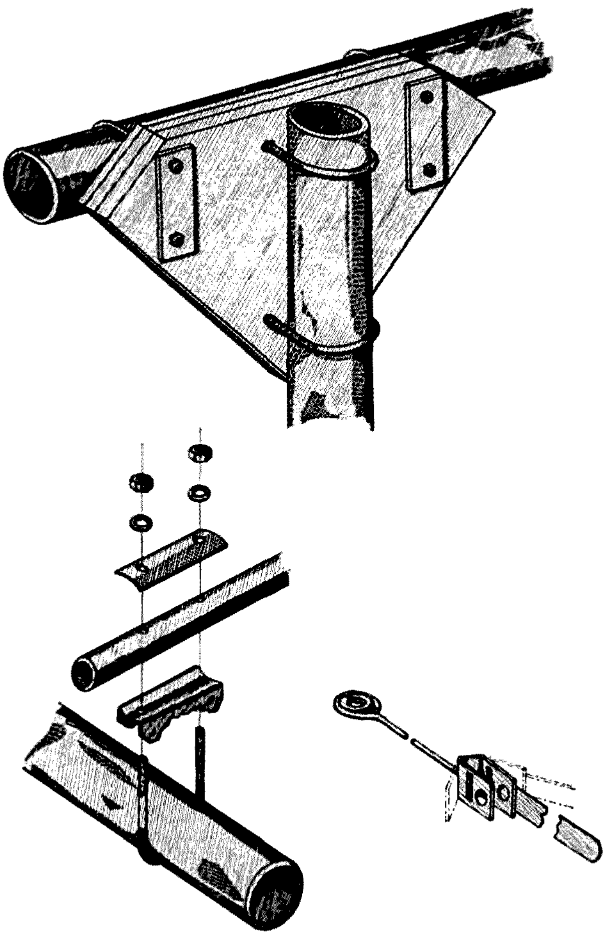


Fig. 2. Top: Boom clamp. Not shown are serrated yokes used with TV most clamps to attach boom clamp to mast. Bottom: End view of stand-off insulator showing insulated wire twisted around element wire on one side of insulator, passed around outside of loop and twisted on opposite side to secure element wire to stand-off insulator.

beam show that the greatest usable portions fall above the design frequency in the case of the reflector-type beam. On the high side, the curves drop off slowly, while on the low side, they drop off rapidly as they near the self-resonant frequency of the reflector. For this reason, a design frequency in the low end of each band was chosen. The performance curves for the quad indicate that it will perform with near-maximum effectiveness across the entire 20 M and 15 M bands and across the greater portion of the 10 M band.

The design frequencies for the Poorboy MK II are 14.1, 21.2 and 28.8. The side dimensions as determined by the formula 250÷f (MHz) are 17′8″, 11′9″, and 8′7″.

Use #14 stranded wire as it is inexpensive, easy to handle and lightweight. Place a small dot of the XYL's brightest nail polish about 6″ from one end. Measure half the distance of one side and mark it with polish. Measure three full sides and mark each with polish. Last is another half side. Cut the wire about 6″ beyond the last mark.

Complete the 10 M and 15 M elements by fastening the ends of the wires to 3″ center insulators at the dots and solder. The 20 M elements must be left unfastened on one end until later.

Tuning stubs provide the mechanical means for varying the length of the reflector elements to tune the antenna to its maximum effectiveness. The reflector is approximately 5% longer than the driven element. The stubs consist of suitable lengths of #12 bare solid wire spaced 3″ apart and soldered across the center insulators of the reflectors. Sliding shorting bars used for tuning are made from small bits of solid wire with clips attached to each end to facilitate moving them easily.

Tuning stubs are 38″ long for 20 M, 22″ long for 15 M and 18″ long for 10 M. These are maximum lengths and after the proper positions for the shorting bars are found, cut off the excess stubs and solder permanent shorting bars at these points.

Select the long section of the frame. This will be the reflector. Lay it with the boom upward on the most level area of the lawn. Slide two hose clamps on each end of the center sections and insert inner sections. Slide a 7½″ SO insulator followed by two more clamps on each inner section. Next, insert tip sections with dowel locked in place and with a 3½″ SO insulator attached.

Note that the length of the arms is to be measured from the point where the arms cross. Measure from cross to ends of inner sections and equalize with about 1′ insertion. Set tip sections so that holes in dowel are 12′6″ from cross and in line with wire direction. Place SO insulators exactly vertical at 8′4″ and 6′2″. These settings are approximately correct as a starting point.

Tighten all clamps and insulators enough that they will not slip but do not lock.

Raise assembled section in the air by the boom enough to clear the ground. Gently lower straight down to allow arms to fall naturally into position. Measure to be sure tips are equidistant from each other. Drive small pegs in the ground in pairs at several points along the arms to insure their staying in place.

Slide 20 M element into place with its center insulator on the cross side of the boom. Place dots at holes in dowel. Use small scraps of wire to tie elements to dowel to prevent slipping. Attach the other two elements in a similar manner and adjust by manipulating the SO insulators. Use INSULATED wire to tie these elements to insulators.

Do not attempt to pull element wires tight as this will cause a severe bowing effect. Allow

all wires to hang loosely. Attach tuning stubs.

Securely fasten boom clamp to mast and loosen clamps used to hold boom. Raise reflector section, slide through clamps and lightly lock into place to await completion of the other section.

Assembly of the second section is identical to the first. 72 ohm coax is connected directly across the insulators. Upon completion, hoist it up and mate it to the first section, and lock in place with the aligning bolt.

Although a lower boom is not an absolute necessity, it serves several purposes. It will eliminate much of the quad's tendency to whip in severe winds. It supports the weight of the feedlines and tuning stubs and reduces the bowing of the arms from the weight of the elements, etc.

A light, well-varnished piece of wood of sufficient length will serve well. Mount it to the mast by a TV clamp or U-bolt at the height of the 15 M insulators. Tie the 15 M elements to the lower boom. Run feedlines out one end of the boom and tie tuning stubs to the other end and this completes construction.

With proper care and consideration in construction, the Poorboy MK II should last for years. Treat all wood with several coats of good, high grade, spar varnish before assembly. Hang the dowel with a thumbtack driven in one end from a clothesline and this job is no problem. Remember to cover the ends of the dowel and the insides of the holes. After assembly, give it another couple of coats to protest against unseen nicks and scratches. Give all metal, except the tubing, generous coats of aluminum paint both before and after assembly.

Tuning is accomplished by pointing the back of the quad at a nearby cooperative ham buddy who provides a steady, horizontally polarized carrier at the design frequency which is tuned for the lowest reading on the station S-meter by sliding the shorting bar along the stub. After each band is tuned, check the other bands for deterioration of F/B. Readjust as necessary. The point of highest F/B lies in a narrow range. Remember that the F/B obtained during tuning will not be the same for all received signals due to different angles of received signals. It would be wise to test F/B with as many local hams as possible and choose a best average setting.

Tests were run using separate feedlines and using a single feedline for the three bands. Interaction during tuning was more noticeable in the case of the single feedline but tuning was no more difficult. In actual operation, there is little to indicate that one system is superior to the other. However, as with all multi-band antennas fed with a single feedline, the chance of harmonic radiation is great enough to give the nod to the separate feedline system.

To connect the three driven elements to a common insulator for a single feedline, adjust the two lower corners of the 20 M element in toward the boom enough to allow the wire to reach the 15 M insulator. Adjust the lower SO insulators of the 10 M element toward the boom and run the wire to the now-common insulator centered in the 15 M element.

The frame of the Poorboy MK II can be used for a mono-band 20 M quad, a 20/15 M and 20/10 M dual-bander. In the event a 15/10 M dual-bander is desired, the metal part of the arms can be reduced to a length of 12′ with suitable 3′ lengths of wood dowel inserted 6″ into the tip sections to bring the total length to 17′. Both the 15 M and 10 M elements can be threaded through the dowel, eliminating the SO insulators. The boom can be simplified by using a single section of TV mast cut to 5½′. In case you've been wondering, this version was the MK I which was cannibalized in the development of the MK II.

Antenna purists frown on the use of coax to feed a balanced antenna such as the quad with no matching device. However, it is a common practice and the performance of such an arrangement seems to suggest that it works better than a casual reading of the textbooks indicates.

The use of metal arms for the quad seems to be a neglected subject. The greatest danger is resonance at an operating frequency. In this case, the arms are close to resonance at 21 MHz. Avoid an arm length of less than 24′.

During the experiments with multi-band quads, the author received the distinct impression that the use of 20 M and 10 M quads on the same frame left a lot to be desired. Interaction between these two was definitely more noticeable than other combinations on the same frame. The answer is probably due to the harmonic relationship. For this reason, a design frequency of 28.8 MHz was chosen on 10 M. Also, this combination never seemed to produce as sharp a pattern as other combinations. Lacking the wherewithal to continue it further, the matter was never fully pursued.

The author realizes that the Poorboy MK II is not the ultimate in quad design but offers it as a good compromise for the average ham with limited resources. . . . K4USK

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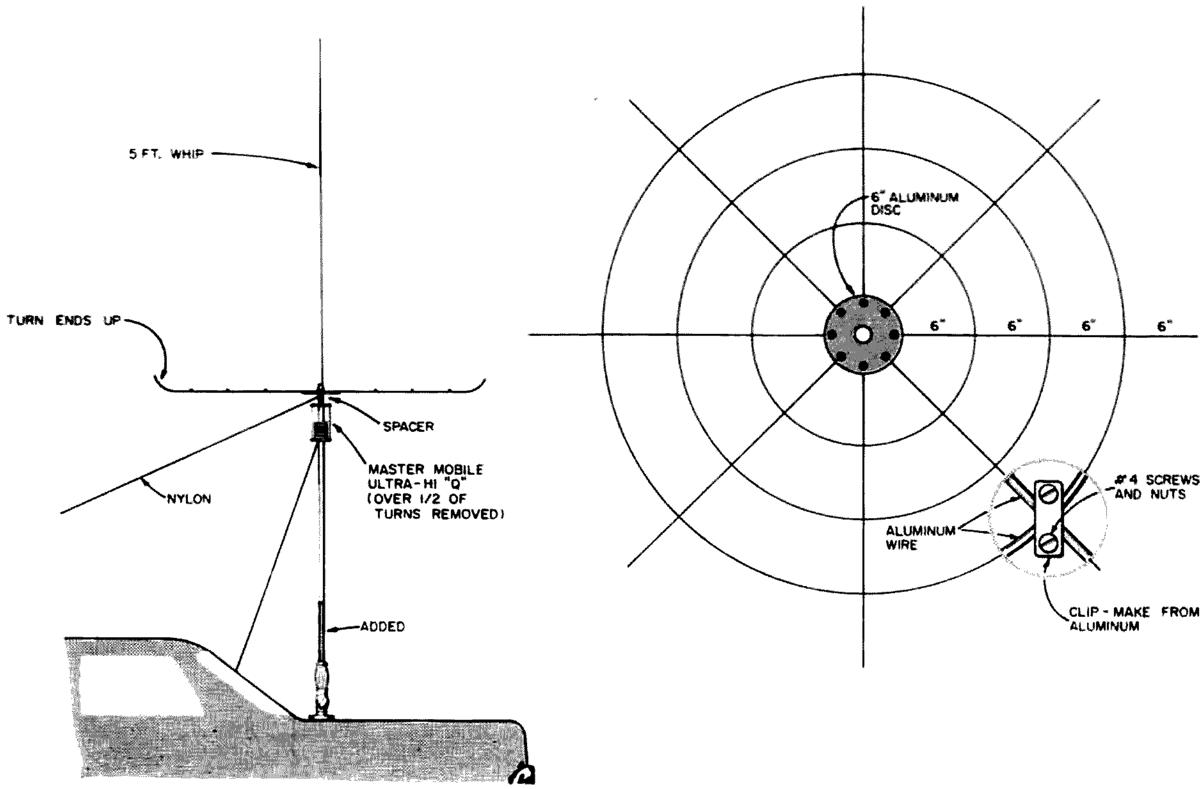
Want 5dB Gain on 75 Meter Mobile?

This article will tell you how to substantially increase your 75 meter mobile signal. The solution is not for the timid or the finicky. It's for the ham who is master of his own car, and really wants a big signal.

In case you haven't given it a try, 75 meters is a very good mobile band. It doesn't close down at night like 20 meters, or become infested with commercials like 40 meters. Also, the home stations don't have big beams on 75 meters, so you can give them a tussle.

Most commercial mobile antennas have calculated overall efficiencies of between 2% and 4%. There may be some arguments at this point, but check with the mobile antenna books and Terman's, and figure it out for yourself. The radiation resistance is very low for short antennas, and the loading coil resistance, and car body and ground resistances are very high. With 75 meter mobile antennas nearly everything goes up in heat. Let's see how we can radiate more and heat less.



The Big Signal 75 meter capacitance loaded mobile antenna.

First, make the antenna as high as the law and your normal travel route permit. Also, mount it up on the back deck of the car where it is out in the clear. You can probably add two feet or so to the regular base section and still not exceed the height limit.

Up goes the radiation resistance and up goes the efficiency. Now perhaps the efficiency becomes 3% to 5%. The center loading coil has moved up, but that hasn't done any harm—perhaps helped a little.

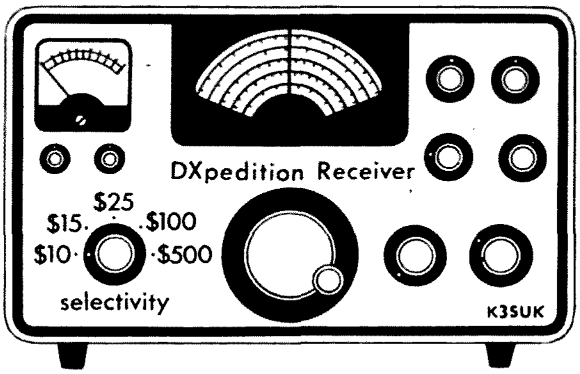
To match the antenna to your 52 ohm feed line, shunt about 1500 picofarads from the base of the antenna directly to the car body. Don't use a coil at the base. It is more trouble to install, and has more loss. The capacitor will do the trick. You may have to adjust the value somewhat. Use your VSWR meter.

What next? We can't go higher. Let's look at the loading coil. Larger wire has less loss, but as the wire becomes larger the coil begins to grow in size and weight to hold the same inductance. A good high Q coil is fine, such as the Master Ultra Hi Q. Trying to improve over this coil is a rough game to play. Silver plate the wire? The improvement is hardly worth the trouble. The way to lower the coil resistance is to cut down on the number of turns. The way to cut this down is to increase the antenna capacitance above it.

One way to increase the capacitance would be to use a large diameter pipe above the coil, but this is not practical. Think of the trees, and the five foot flexible whip remains. What can be done with a capacity hat? The answer is—plenty!

If you want to develop your own top loading arrangement, start by obtaining a coil of aluminum clothes line wire. It appears to be a little larger than #8. Cut an 18 inch piece, and install it on about a 3 inch spacing rod above the coil. Head the wire aft. You will be able to take a few turns off the coil and still be resonant on the same frequency. Fine, how about four of these lengths, arranged like a two meter ground plane. Off come more turns. You can do the trimming with nothing but your rig and a VSWR meter if you go slowly. Keep the power way down. Don't add too much capacitance at once or you may find resonance outside the band, and you will need more than the rig and a VSWR meter to straighten things out.

The aluminum wire is surprisingly strong, and is self supporting at lengths up to more than two feet at fast car speeds. With the four radials and the increased height, the antenna efficiency has now become somewhere near 8%. File sharp edges to prevent corona and receiver noise.



If you still have courage, lengthen the radials a little, double the number, and strengthen them with three concentric circles of the same material. You now have a big capacitance hat of good strength. A 6 inch aluminum disc in the center can serve as a good building platform. The aluminum wire can be joined by small clips and screws, or binding with wire and covering with aluminum solder, or better yet by means of Heli-arc.

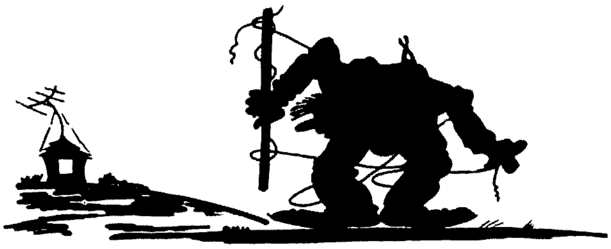
A capacitance hat of this type will allow you to cut your coil down to less than half of its original size. Efficiency will now calculate to be 10% or higher. Your actual output should have increased by at least 5dB. The 200 watt PEP rig has now become the equivalent of about 700 watts. You don't need a linear, and all of the problems of supplying power. Now, at 10% efficiency, you have a good vertically polarized signal. The efficiency has started to approach the efficiency of some home station ground plane antennas.

It is recommended that a light nylon cord be run from just above the antenna coil to the forward rain gutter, and another to the deck opposite the antenna base. These guys will stabilize the antenna at high speeds, and prevent it from swinging over the highway in a cross wind.

A second coil, which will resonate without the capacitance hat, is recommended for use when the hat or guy lines are not desired.

The writer has used an antenna of this type for over a year. Results have been very gratifying. The mobile signal is consistently stronger than other mobile signals of equal power using conventional antennas.

. . . W3BTQ/5



. . . a couple of wires, a long ruler, and a short conscience.

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High Accuracy VHF Frequency Measurements

Measure your VHF frequency to better than .00015%.

In years past the only need for a VHF frequency measurement was to make sure that the transmitter was in the right band. This could usually be taken care of with a couple of wires, a long ruler, and a short conscience. But life in the ham bands has changed. New narrow-band techniques and equipment make it necessary to know much more about frequency than just how to find the band. This is especially true in certain types of DX work. Frequency measurement capability also has its fringe benefits if you happen to belong to the "net set." You can alienate your friends, lose your peace of mind, and do wonders for the net by just reminding everyone at frequent intervals that he is off frequency, or drifting too badly to be measured.

Accurate frequency measurements can be a problem for the amateur with a limited budget. However with some home construction and careful operation the average ham can make VHF frequency measurements to an accuracy better than .00015% at two meters. This is the equivalent of measuring the distance from New York to Los Angeles with an error of only 25 feet. Many commercial units cannot equal this figure. The same method can also be used for HF and UHF measurements.

There are many ways to measure frequency but few of them are satisfactory for use at the very high frequencies. The well known hetrodyne frequency meter becomes unstable when its oscillator is operated at VHF. It can no longer be held or read to any degree of accuracy. The oscillator can be operated at a low frequency and one of the harmonics used at VHF, but any error in the oscillator will be multiplied by the number of the harmonic used. A frequency meter that can be held to within 200 hertz at 4 MHz will be off by 7.4 kHz at the 148 MHz harmonic.

A second method of much greater accuracy uses low frequency crystals which are referenced to a known standard such as WWV. The harmonics of these oscillators will be quite accurate and useful far into the UHF region. However this system has its limitations. Even when used with multivibrators and harmonic amplifiers it produces only spot frequencies.

Although neither of these two methods is satisfactory when used alone, they can be combined to make an accurate and versatile

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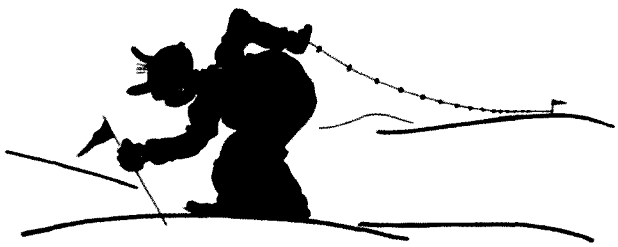
Howard, former W9TGU, W7KGD and WØBDH, has written many articles in his 32 years of licensed hamming. He now works for Sandia in AEC primary standards.

But life in the ham bands has changed.



. . . from New York to Los Angeles with an error of only 25 feet.

system. If you haven't guessed it by now, the system works like this. A crystal oscillator operates on 5 MHz. This oscillator can be kept to zero beat with WWV with very little effort. With a simple harmonic amplifier following it, strong markers are available every 5 MHz far into the UHF region. To fill in between the 5 MHz points, and get full tuneable coverage, all that is required is to add the output of a stable low frequency VFO to the proper marker. Example: To measure 146.25 MHz just add 1.25 MHz from a calibrated tuneable oscillator to the 145 MHz harmonic of the crystal. The same results can be had by using the 150 MHz marker and substracting 3.75 MHz.

The tuneable low frequency oscillator of this hetrodyne system can be any stable, calibrated, oscillator that will give the desired frequencies. A good signal generator can be used but better yet is the old faithful BC-221 frequency meter. The crystal oscillator that supplies the 5 MHz markers should be designed for high stability. However, even simple crystal-controlled units can be kept zero beat with WWV for periods long enough to make most measurements.

Earlier we quoted a figure of .00015% or better for the accuracy of this system. Perhaps we should show how this is possible. The crystal oscillator can be held to near zero beat with WWV but due to propagation errors in the signal of WWV, we can never be sure that our crystal is closer than 2 parts in 10 million. This would be 2 hertz of error at 10 MHz or an uncertainty of 29 Hz in the 145 MHz marker. The BC-221 is normally considered to be a .05% instrument. This would be an error of about 1.75 kHz at 3.5 MHz. However with care in calibration, and reading it is not difficult to reduce this value to 200 hertz or less. In a hetrodyne system the error of the VFO is not multiplied at VHF but is just added to the error of the crystal marker used.

The total error at 2 meters is 29 Hz contributed by the crystal and 200 Hz by the VFO for a total of 229 Hz. This is a little more than 1.5 hertz per million hertz for a tuneable system. Of course these values are approximate and with careful operation they can be reduced by 50% or more.

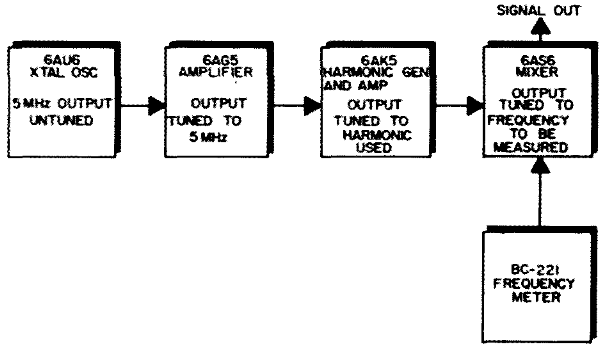


Fig. 1. Block diagram of the VHF frequency meter.

In the 146.25 MHz example used earlier, the VFO was required to furnish less than 1% of the total output. To put it another way, the only wobble is in the smallest cog and its contribution is so small it can't shake up the machinery too much.

The circuit shown in **Figs. 1 and 2** has been used for monitoring MARS, CAP, and several other services. The crystal oscillator is quite stable but can be tuned enough to zero with WWV. Tuning is done with C1. One stage of harmonic amplification is sufficient to give strong signals well above 150 MHz. The plate circuit of this amplifier stage is tuned to the harmonic to be used. This feeds one input grid of the mixer. The other grid of the mixer is driven by the output of the BC-221 frequency meter. The tuned circuit shown in this grid resonates broadly in the 2-4 MHz range of the BC-221. This helps to keep the higher harmonics of the BC-221 out of the mixer.

The output of the mixer is resonated to the desired operating frequency. This will be either the sum or difference of the two input signals. The level of the output signal can be controlled by **R6**.

Operation of this system is simple. The "cook book" would read as follows:

1. Couple the output to the antenna of the VHF receiver.
2. Determine the crystal harmonic and VFO frequency that will give the frequency of the signal to be checked.

. . . the only wobble is in the small cog . . .

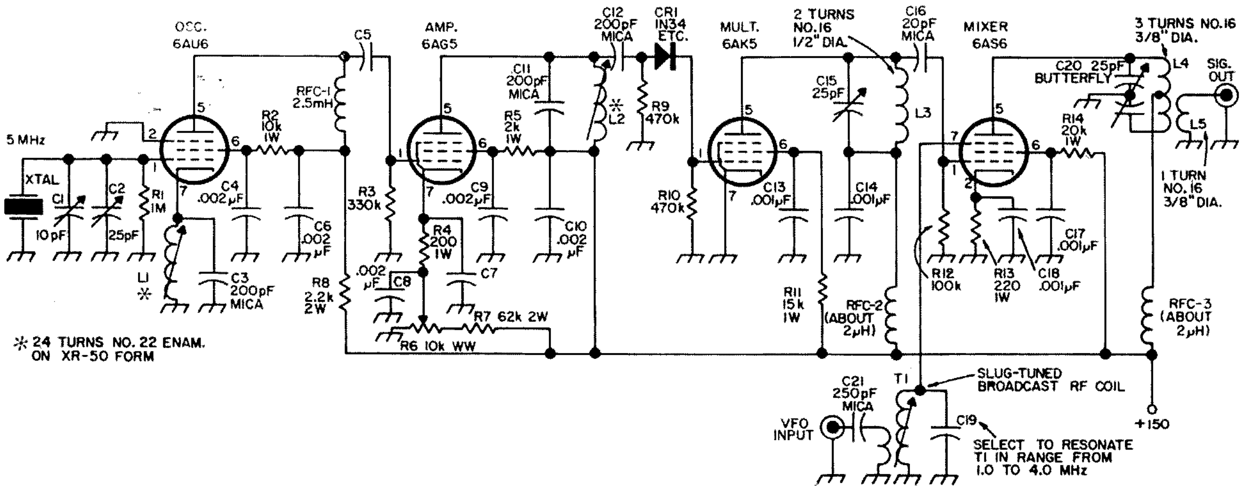


Fig. 2. Schematic of the oscillator, multipliers and mixer for using a BC-221 on the VHF ham bands.

3. Tune the VHF receiver to the signal to be checked.
4. Tune the BC-221 until the output of the frequency monitor zero beats the received signal.
5. If required, peak the tuned circuits in the monitor for maximum output and adjust R6 as needed.
6. The frequency of the received signal will be the crystal harmonic plus (or minus) the reading of the BC-221.

Many details cannot be covered in one story due to lack of space. The operator will have to determine the most effeceive method of coupling to this particular receiver. He will also have to explore the many combinations of frequencies which can be used. These and many other questions cannot be included at this time. However those who require such a system as this will probably be capable of filling these details.

One word of caution is in order. With two oscillators that are rich in harmonics, there can be many unwanted "birdies." These present no problem after the operator has gained experience but the new user should be very cautious. Many times an unwanted beat can be eliminated at a critical spot by changing the two frequencies that are being mixed (shift from sum to difference).

Perhaps we should emphasize that this system is a "trade off" where the amateur can trade his skill and patience for highly accurate measurements with simple equipment.

. . . W5WGF

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Adding Sideband AGC to Your Old Receiver

There are several ways of adapting an older receiver for SSB reception.[1] "Product detectors" are often mentioned, and the words look very nice in the promotional literature. As any student of instruction books can tell you, there are many ways to get good sideband demodulation, and only a few of them are protected by valid patents . . . not that that matters to the home constructor. Any diode detector is a product detector provided that the BFO voltage applied is as strong as the peak of the strongest signal, and also provided that that strongest signal is somehow kept *within* those bounds, preferably by some sort of fast-attack, slow-release AGC.

1. For instance, the NC-300 is not very good on sideband as it stands, but the NC-303, changed only a bit, has reasonable action. I intend fixing up a friend's NC-300 for better sideband AGC in the near future; it appears from the circuit diagram that a 2 μF capacitor is all that needs to be added (Drop me an SASE and I'll let you know what we finally did). I have also made some modifications to the SP-200 and —400 series Super Pros which seemed to help.

The conversion described in this article enabled me to add sideband reception *with* AGC to three receivers with a minimum of butchery and without adding too much to their internal crowding. In one of them the BFO tube was also used to run the S-meter on phone; by adding a couple of transistors (*seventy-cent* transistors, my favorite brand) I got a separate S-meter amp with no new socket holes and no extra power drain. I'm happy I did it, in all three cases.

The circuit diagram (**Fig. 1**) shows the AGC, MGC, audio and S-meter circuits of the receiver that had the most done to it. If the whole thing overwhelms you, the obvious course is not to start any modifications. As a matter of fact, the drawing is simplified: where it shows a three-pole two-position switch, I used a four-pole five-position type. It now appears that I wish I had used a six-pole five-position, shorting, and if having a switch labeled PHONE-USB-LSB-CWU-

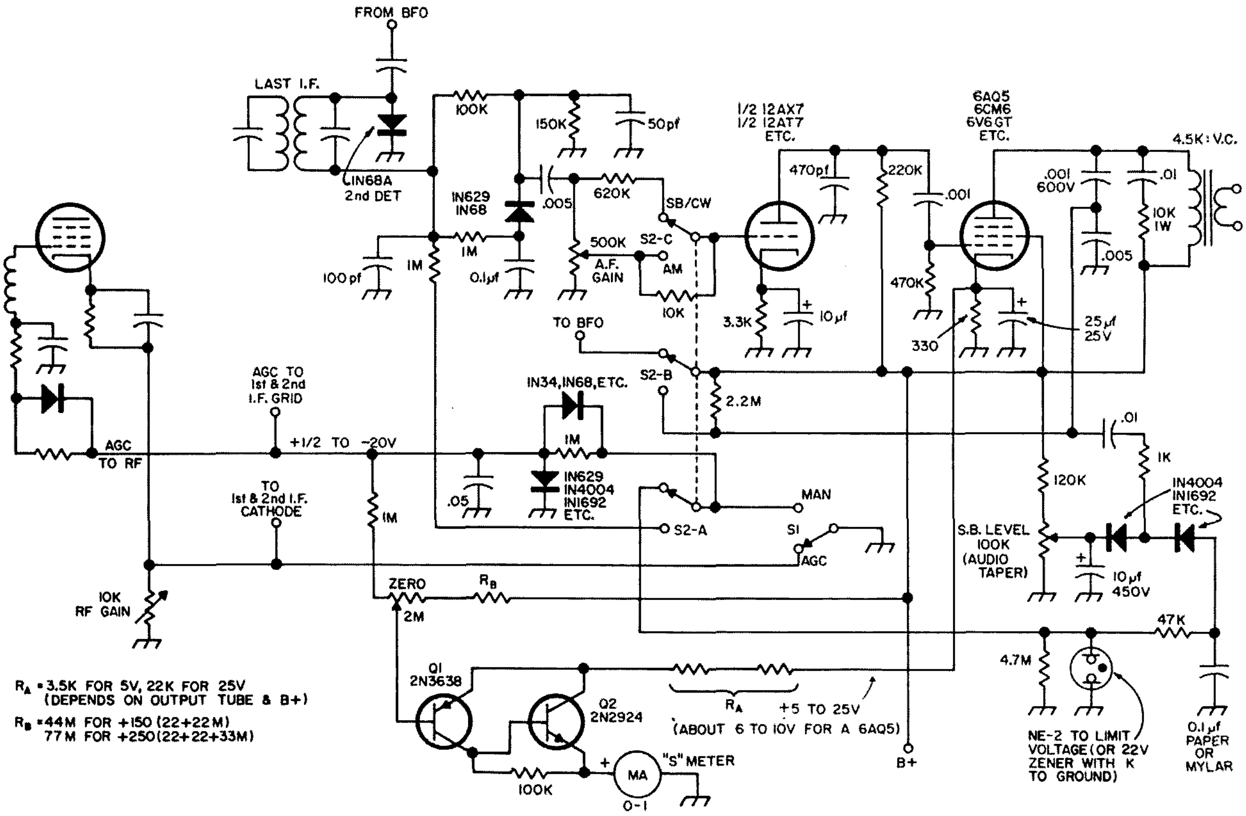

Fig. 1. SSSB AGC system with transistor S-meter amplifier, MGC and audio circuits. This is an excellent adapter for many old communications receivers. SSB level and AF gain should be ganged for best results Adding the RF gain to the same shaft is also nice since it makes room for the SSB-AM switch. The .1µF capacitor in the lower right should be 1µF.

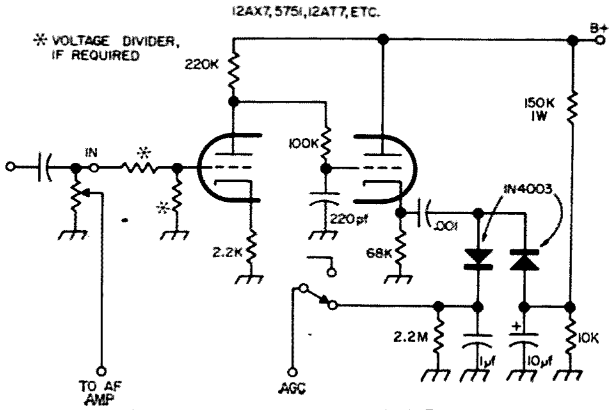

Fig. 2. Tube type audio derived AGC. Take audio from after noise limiter and before audio gain control.

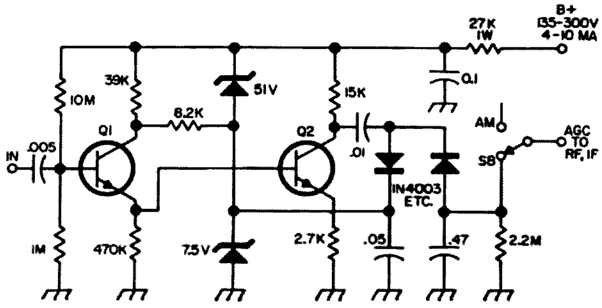

Fig. 3. Transistor audio derived AGC. Q1 is a 2N2925 (25¢), Q2 a 2N3404 (85¢). The 7.5 volt zener is ¼ or ½ watt, such as the 1N958 or 1N755. The 51 volt zener is a ½ or 1 watt one, such as the 1N3036. Pick up the signal as in Fig. 2.

CWV sends *you, I* could send a *circuit* (*in* a SASE).

The audio-derived AGC was originally suggested by a note in a *Swan* manual. Incidentally, doing it their way worked in one receiver but in another the silicon power diodes used to rectify the audio voltage produced harmonics which got into the *if* and fed back. The resistor (1000 ohms in the diagram; the value is not critical at all) ruins this "varactor action" without any other ill effects. The charge time constant, in practice, is a few milliseconds; if it's made too short, the receiver quits whenever a Ford drives by. The AGC "delay" bias (the value of peak voltage below which no AGC voltage is developed) is adjusted by the potentiometer labeled SB LEVEL. I found that this worked best if it was ganged to the volume control, so that the volume adjusted by the same knob in either mode. If this is done, the volume control circuit must be doctored up so that the gain of the audio section is never reduced all the way, (although *some* variation in the audio gain did turn out to be desirable) and the net result is the circuit shown.

Whether you like the manual gain control ganged with the audio gain (BC-348 style) is a matter of taste; it only operates in the MGC mode, which is when the audio pot doesn't in those receivers. Ganging THAT with the other two is a possible way of freeing a panel hole for use as a switch for AM-SSB. The only way I know to buy a three-gang pot is to make it up from IRC parts.[2]

Some of the switching is to make sure that the 1 µF capacitor cannot start out with a charge when you switch to SSB. For some other ideas, see a previous article[3] on the same sort of thing.

The S-meter circuit requires a silicon PNP and an NPN transistor. These both are now fairly cheap and common. The AGC delay on AM is about three volts, caused by the bleed current through the 44 megs or so in the divider which is part of the S-meter circuit, the 1 meg AGC filter resistor, and the 1N629 diode clamping the AGC bus. The bleed current also affects the release time of the AGC in the sideband mode. The 2 M pot is to set the S-meter to zero for no signal, and the "CAL" pot is to set the *maximum* meter reading. With the values given, the motion was reasonable over the range of AGC volts from 0 to minus 10. Q1 and Q2 should have reasonably high gain at low currents and BV_{ceo} at least as high as the rated cathode bias of the output tube. I put both transistors on a card screwed to the back of the S-meter by its terminal posts. The holes for the pots were already in the chassis from the previous S-meter circuit.

If you'd like a little simpler modification, almost any receiver (without restriction, if it uses tubes) can have audio-derived AGC added by attaching one of the amplifier-rectifier units shown in **Figs. 2 and 3.** The input impedance is high, and the extra power needed is small; the gain is adequate and, in fact, may be excessive. If it is too high, the receiver will be short of audio output on sideband. A suitable cure is to put a one megohm potentiometer at the input and adjust so that the sideband audio matches the AM audio. The cost for all parts for the transistor model is just under $15, and the silicon transistors permit it to be put in a fairly hot spot inside the receiver without loss of performance. I built it up on a piece of perforated circuit board and taped it to an *if* can to try it out. Eventually it's going in another receiver, which will have transistor audio and audio-AGC sections but tubes for the RF and *if*.

. . . W1OOP

2. 73 Magazine, Feb. 1964. "Unusual Receiver Circuits."
3. For two-gang, 500k audio is Mallory FA55A, 100k is 15A (second section). There is also a shaft required, you pick it. For two gang, IRC Q- or PQ-13-133 plus M13-128. The RF section can be piggybacked on later, buy IRC M17-116, making three.

The Classic Feed System

By W. E. "BARNEY" ST. VRAIN, WØPXE
DESIGNING ENGINEER - CLASSIC 33 PROJECT
MOSLEY ELECTRONICS, INCORPORATED
4610 N. Lindbergh Blvd., Bridgeton, Mo. 63042.

Code 107.

SINCE the introduction of multi-frequency beams several years ago, the method of feeding such antennas has been a subject of much disagreement. When these antennas were introduced a few years ago, Mosley Electronics ran a series of advertisements in the technical magazines explaining the method used on our Trap-Master and Power-Master series. Since that time we have tried a wide variety of feed systems endeavoring to improve on the original system.

Testing Other Feed Systems

In testing, we found a three band gamma system ineffective without isolation networks which resulted in the feed system costing about equal to the antenna cost; with a system using hairpins, the cost proved low but did not provide a better match than the original Mosley matching system. It became quite clear to us, the Mosley system was hard to beat, for we had found only one slight disadvantage, the elements needed to be stagger tuned to raise the feed point resistance from about 30 to 50 ohms. This slight detuning, which proved advantageous in increasing the bandwidth, brought about, in turn, a slight gain loss of about 0.5 to 1.0 db. at resonance.

The Classic-33 System

In order to give hams a new choice in beam matching systems and an antenna featuring maximum gain with increased bandwidth, we devised the matching method used on our New Classic 33 antenna, a method which takes advantage of the principle that antenna resistance at the center driving point increases as the antenna length increases. Figure No. 1 shows the radiator element of a three element beam at resonance having an impedance at the driving point (Z_A) of about 30 + J0 ohms. If the element is made longer, Z_A can be raised to about 50 + J50 ohms. (Figure No. 2) Since the reactance is inductive, it can be canceled with a series capacitor of 50 ohms reactance, leaving 50 ohms feed point resistance. (Figure No. 3) Series capacitors used on the Classic 33 are made by inserting a suitable length of heavily insulated wire into each half of the element tube at the center. The wires are terminated in a plastic tube enclosure with a type "N" connector for connection of the coaxial cable. To isolate the outer coax conductor from ground, the coax line is coiled for a few turns near the antenna end. This is designed to prevent the very unlikely affect of "Feed Line Radiation".

Fig. 1.

$L = \frac{\lambda}{2}$ $Z_A = 30 + \dot{j}0$

Fig. 2.

$L = \frac{\lambda}{2} +$ $Z_A = 50 + \dot{j}50$

Fig. 3.

$Z_A = 50 + \dot{j}0$

Converting Other Beams

This feed system could feasibly be used on our other Trap-Master beams, but little would be gained and the antenna would need to be completely rebuilt. The big difference between the new Trap-Master beam and the TA-33 is that the latter has conversion features, while the Classic 33 does not. The engineers at Mosley designed the Classic 33 to give the ham a little extra gain on all bands. It is our conviction that discriminating DX'ers will find this new tri bander specifically suited to their needs, but hams buying the well-known TA-33 will still enjoy a superior quality DX antenna with a gain very close to that of the Classic 33.

Dennis Bryan W2AJW
4 Crescent Drive
Apalachin, New York

The Ultimate Station Control

Arrange your station for perfect break-in and complete control of antennas, power and changes of equipment.

How many times have you visited a fellow ham's shack and left wishing that you had a set-up like his—a set-up that was a pure pleasure to operate? How many times have you tuned the low ends of 80 and 40 and listened to the brass pounders operate full CW break in and felt like joining the fun? You knew you couldn't join in because of the manual receive-transmit switching you have and so you dejectedly tune off frequency looking for a "you send awhile—then I send awhile" QSO. How many times have you rejected the idea of building or buying a TR switch because they "suck-out" signals in the transmitter tank circuits in receive mode?

Well friend, read on and find out how you can organize your equipment into a sweet running system that'll make you beam with pride. But—WARNING!—you may have to buy your XYL a fur coat to compensate for all the operating time you'll be putting in with your rig once you get it working in this type of system.

Although few hams will have the exact equipment configuration as this system the features of this control unit can be applied to almost anything you may have.

The highlights of this system are:

1. Full break in by using a TR switch with no signal "suck-out" at all after being in receive mode for a couple of seconds.
2. Automatically switches to transmit mode when the key contacts close or the VOX relay is activated.
3. Allows rapid change (flip of a switch) between exciter only or amplifier operation.
4. Controls DC input to final amplifier.
5. Gives rapid selection of antennas.
6. Automatically mutes receiver when the key is closed.
7. Provides CW side tone. Can be used as a code practice oscillator.
8. Allows rapid changes in equipment configurations.
9. Puts only 17 volts, low current, across key contacts—eliminates exposed shock hazard and arcing.

At the end of this article is a list of component functions that will assist your "treck" thru the diagrams without wasting time. A more thorough explanation of the more involved functions is in the text between here and there.

Fig. 1 is a diagram of the RF and antenna selection circuits of the system. By bringing all low level RF circuits up to a patch board on the side of the station control units it is possible to change the system configuration without getting out of your chair. Sure beats crawling behind the desk or table to change connections.

Note that when RL2 is down (de-energized) RF is fed straight thru the amplifier to the antenna circuit. When RL2 is up (energized) the exciter is coupled to the amplifier input and the amplifier output is connected to the antenna circuit.

RL5 is the little gem that prevents receiver signal "suck-out" after the system is in receive mode for a couple of seconds. RL5 is normally down, isolating the antenna circuit from the amplifier or exciter tank circuit, and comes up when the key contacts close or the VOX relay is activated. The use of RL5 along with a TR switch allows you to operate full break in and still be able to hear the real weak DX stations when you are in receive mode.

When S5 is in the 160 meter position RL6 will be picked up. RL9 will stay down because current will not flow thru D9. When S5 is in the 80 meter position RL9 will be picked up and at the same time current will flow thru D9 picking RL6. Although RL6 thru RL9 have 12 volt coils 17 volts is applied because of the long line run to the relays and resulting voltage drop.

The Marconi antenna in this system is ⅜ wavelength long on 160 meters and has a feed point impedance of 120 ohms. Even though this requires a reverse-pi matching network

the higher impedance reduces ground losses commonly associated with Marconi antennas. With the low power restrictions on 160 meters you cannot afford unnecessary losses.

Fig. 1 also shows the RF patch board and jumper diagrams for: 160 meter CW/AM, 80-20 meter CW/AM, and 80 meter SSB. Any of these configurations can be patched in less than a minute. The patch board is made up of phono type sockets mounted on an aluminum bracket. Coax cables going to the various units are soldered to the jacks and have plugs to match the units on the other ends. When you get that new piece of equipment all you have to do is unplug the old unit and plug the new unit in. All the RF circuits of the new unit will be available at the patch board ready to go.

Fig. 2 shows the 110 VAC primary circuits of the control unit. The operation of the primary circuits is quite straightforward. It is important that S1 and S2 have the indicated current rating. RL2, RL4, and RL5 are Guardian Series 200 DPST relays with like contacts wired in parallel to increase their current carrying capacities. Here also, flexibility was the prime goal. Jacks J7 thru J11 will provide controlled primary power for any piece of equipment you have—unless you're bootlegging with a 10 kW job.

Fig. 4 is a graphic representation of what actually happens inside the control unit when the key contacts close or the VOX relay is activated. The lines shown in **Figs. 4A, C,** and **D** and referenced to **4B** which represents in this case the letter "L" being sent with the key. The up levels show the key contacts closed and the down levels show the key contacts open. By working your way from left to right on line **4B** and taking a reading on lines **4A, C,** and **D** each time the level of line **4B** changes you can see exactly how the break in function of the control unit works.

At first glance the transistor circuits shown in **Fig. 3** looks a bit complicated to digest. Actually, all the transistors except Q8 and Q9 are used as switches. They are either in a state of conduction or completely cut-off. This makes the selection of transistors to use quite simple. About anything you have in your junk box will work. The ones used here, other than Q8 and Q9, were obtained from Radio Shack and didn't have any commercial type indicated on them. They were removed from scrapped computer circuit boards that Radio Shack has for sale. Q8 is a 2N718 and Q9 is a 2N269 as recommended by Robert D. Corbett in his July 1965 73 Magazine article "CPO-CWM" that described the CW sidetone oscillator used in this control unit.

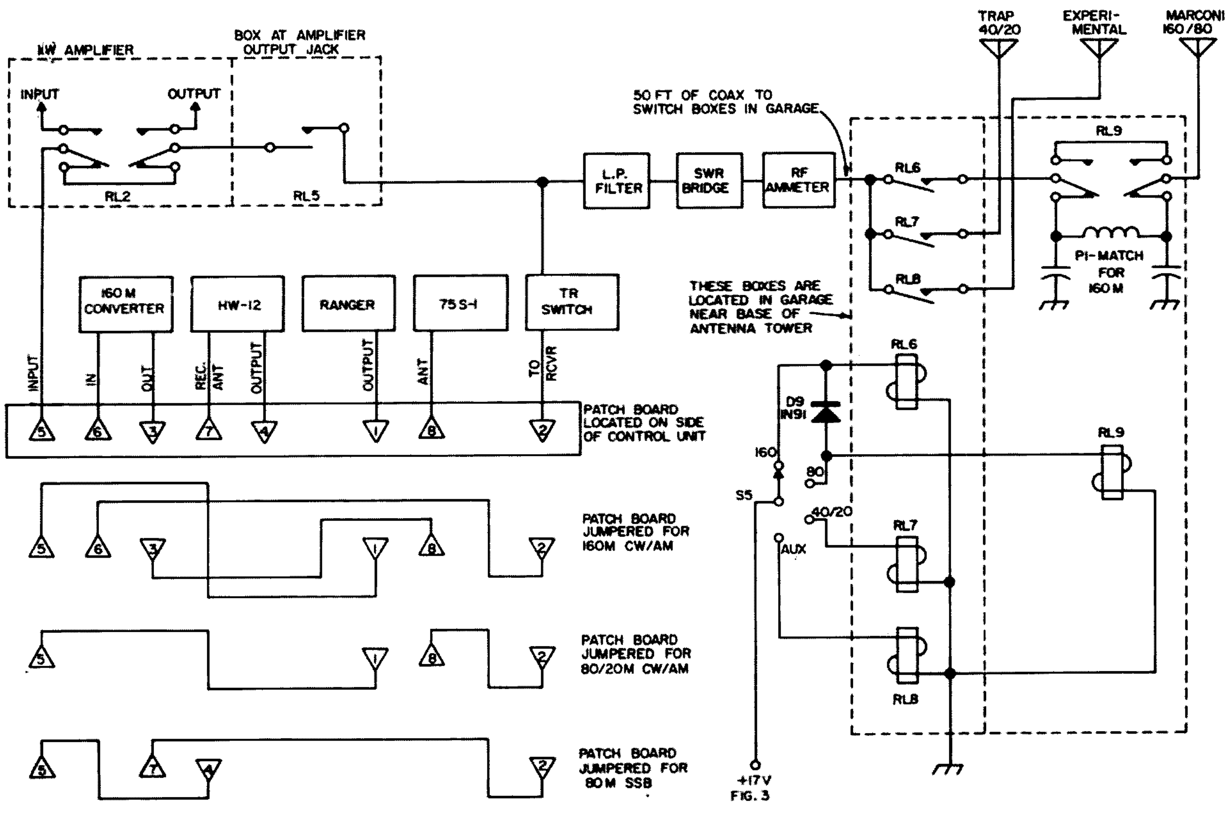

Fig. 1. RF routing and station configuration of W2AJW's station control system. The function of each major part is explained at the end of the article.

To determine if a transistor is conducting note the relationship of base voltage to emitter voltage. If the transistor is an NPN type like Q1 and the base is more positive than the emitter it will be conducting. If, in the case of Q1, the base is negative in respect to the emitter the transistor will be cut-off and no current will be flowing thru it. Just the opposite is true of PNP transistors, like Q4. When the base of Q4 is positive in respect to its emitter it will be cut-off.

Let's take a look at Q1, Q2 and RL3A and RL3B. In receive mode with the key contacts open the bases of Q1 and Q2 are at minus 17 volts. Because the emitters of Q1 and Q2 a biased to a minus six volts they will be cut-off and RL3 will be down. When the key contacts are closed, as in the first dit of the character "L" shown in **Fig. 4**, the bases of Q1 and Q2 will be shorted to ground thru the 330 ohm resistor. Now that the bases are more positive than the emitters Q1 and Q2 will go into heavy conduction with current flowing thru RL3A and RL3B picking up RL3.

Simple huh?

By keying the bases of Q1 and Q2 rather than keying the relay directly you have removed that source of high current from the key contacts and eliminated that source of arcing and key-clicks.

RL3 has two coils mounted side by side. The coils are each 5000 ohms and are wired in series by the manufacturer. This application requires that the connecting wires be removed so that the coils can be wired as shown. You must experimentally determine how to wire the coils so that when both coils are wired in this circuit the fields do not oppose each other. If they do oppose each other the relay will not pick up. Why do we split the coils of RL3 into two coils, RL3A and RL3B? This is done to satisfy two conditions. First-to allow RL3 to pick up and close its contacts as quickly as possible to reduce the amount of the first dit or dah that is missed while the station is going into transmit mode. Second-to provide a hold-up circuit for RL3 and therefore stay in transmit mode between characters and words Q1 and RL3A take care of the first condition and Q2 and RL3B and C1 the second.

Diode D5 isolates Q2, RL3B, and C1 from Q1 and RL3A at the instant the key is closed and Q1 and Q2 conduct. Because at this instant C1 is discharged it will act as a dead short across RL3B. If RL3B was the only coil on RL3, RL3 would not pick up until C1 had charged up to the point that enough current started to re-route thru RL3B to attract the relay armature. This would cause a considerable portion of the first dit or dah, in fact quite a bit of the first character, to be lost. Coil RL3A, because it is not shunted by a capacitor and is isolated from C1 by D5 at key closure time, provides the necessary quick pick up time of RL3. When the key contacts

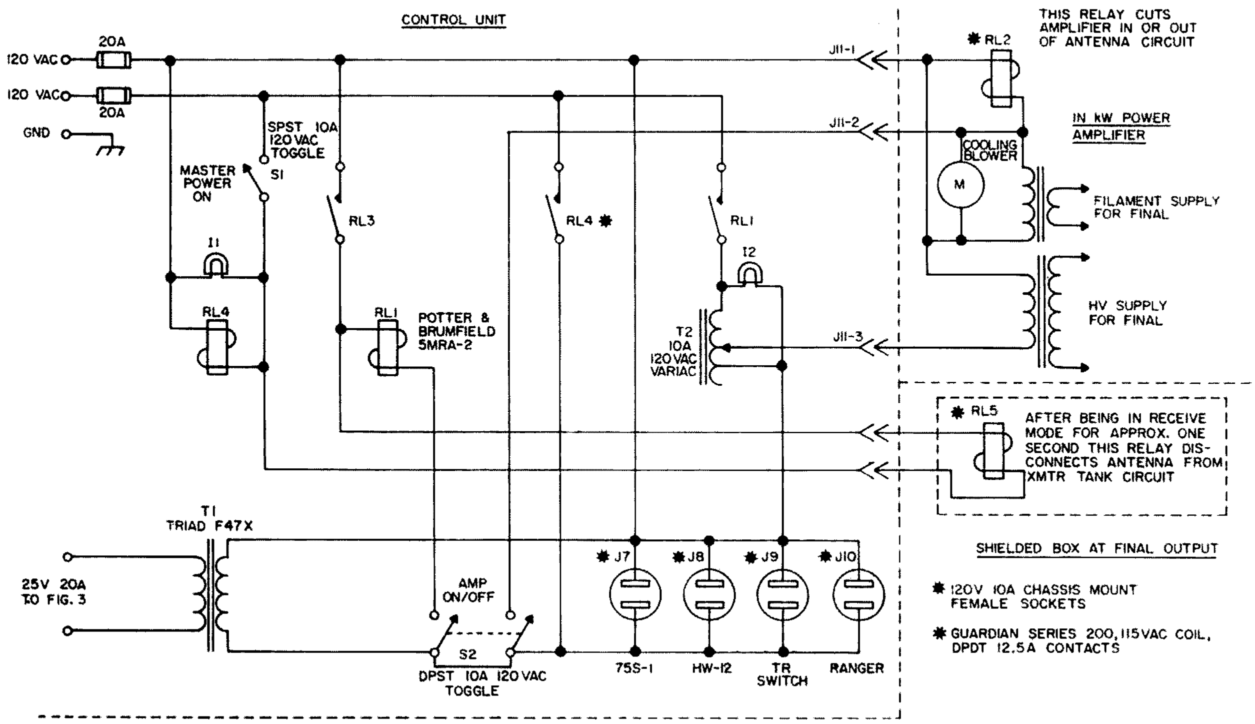

Fig. 2. Primary power circuits and control of W2AJW's control system.

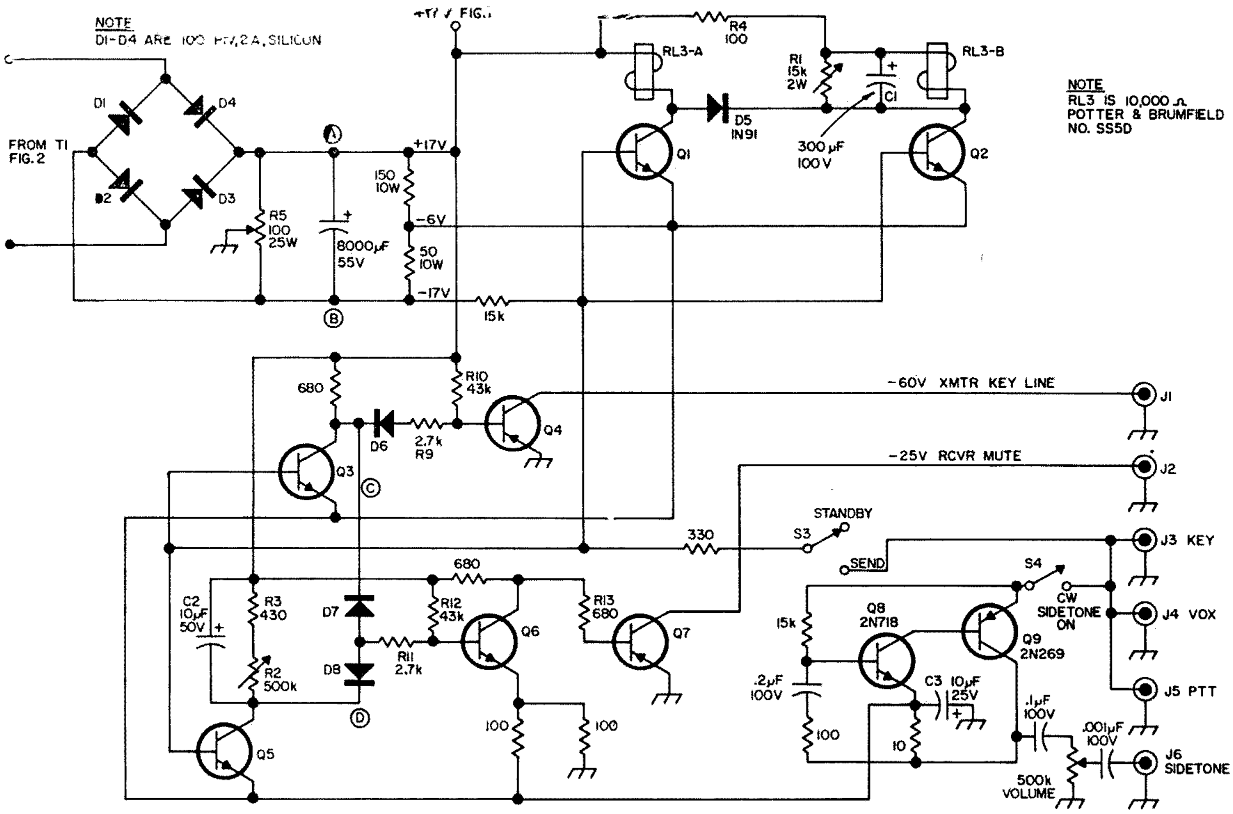

Fig. 3. Transistor switching circuits and code monitor.

open Q1 and Q2 will be cut-off and C1 will have three discharge paths: 1-thru RL3B, 2-thru R1, 3-thru R4, RL3A, and D5. The discharge path thru RL3A as well as RL3B gives a more uniform pull on RL3 armature and better control on its drop out time. Note that the discharge path thru R1 is variable. Decreasing the resistance of R1 will make C1 discharge more rapidly and cause RL3 to drop out quicker.

Q3 and Q5, along with Q1 and Q2, are controlled directly by the key contacts or VOX relay. Like Q1 and Q2, Q3 and Q4 are normally cut-off and conduct when the key contacts close. Q3 controls Q4 and Q6. Q5 controls only Q6. When Q3 conducts its collector goes to a minus 6 volts, current will flow thru D6, R9, and R10. It can be seen from the values of R9 and R10 that the base of Q4 will go to about a minus 4 volts (from plus 17) and Q4 will conduct keying the transmitter.

Now we run into a circuit known as a "minus or". This is made up of diodes D7, D8; resistors R11, R12; and transistor Q6. When the key contacts are open Q3 and Q5 are cut-off and points C and D of diodes D7 and D8 are at a plus 17 volts. Since R12 ties back to plus 17 volts the base of Q6 will be biased so that it will be conducting. With Q6 conducting its collector will be at a minus two volts. This same voltage is applied to the base of Q7 making it conduct putting the receiver in receive mode. (Like many receivers this one is in receive mode when the "receiver mute" line is grounded.)

In order to satisfy a "minus or" all you have to do is "make" one leg of the switch. For instance, if point C was minus and point D was plus, current would flow thru D7, R11, and R12 to plus 17 volts. Since R11 has a much smaller resistance than R12 most of the voltage drop would be across R12. The voltage at the junction of R11 and R12, point E, would be negative. Conversely, if point D was minus and point C was plus current would flow thru D8, R11, and R12 to plus 17 volts. In either case the base of Q6 would be baised to cut-off and the collector would go to plus 17 volts and in turn cut-off Q7 muting the receiver. At the same time we could call this a plus "and" circuit. That is, if both points C and D are plus Q6 will conduct.

When the key contacts close Q3 and Q5 will conduct and points C and D will go to a minus six volts and the receiver will be muted. Capacitor C2 will charge thru the path; minus six volts, Q5, C2, to plus 17 volts. At the instant the key contacts open the transmitter oscillator STARTS to turn off. The turn off time of the transmitter oscillator takes but a fraction of a second but if your receiver has a rapid recovery time, as in my case, you will hear a "thump" in the speaker. Q5, C2, and

D8 eliminate this "thump". Remember it was said that C2 charges when the key contacts close? Well, when the key contacts open C2 has two discharge paths: 1- thru R3 and R2; 2- thru D8, R11, and R12. The first path is variable and is used to control the length of time the receiver will be muted between dits and dahs or characters. The second path is the one that actually holds the receiver muted after the key contacts open. The smaller the resistance of R2 the quicker the receiver will recover. It is possible to set R2 so that all transmitter sound is removed but still be able to hear a break in signal between bits of a character when sending at 20 wpm.

Fig. 5 shows an alternate method of keying a transmitter or muting a receiver. This method would have to be used if your transmitter has cathode keying or if your receiver has a positive mute line. Of course a combination of **Fig. 5** for the transmitter and **Fig. 3** for the receiver could be used, or vice versa.

The relays shown in **Fig. 5** are ultra sensitive radio control units that pull in with only 1.4 mA coil current. If a less sensitive relay is used it will be necessary to increase the voltage fed to the relay. Diodes D10 and D11 prevent ringing in the circuits when Q4 and Q7 are cut-off. At the instant the circuit thru the relay coils is cut-off the voltage in the coils will spike to a very high value and possibly ruin Q4 or Q7. In any case this spike will generate electrical noise.

So there you are. If you want the ultimate in station control then drag out the tools and get busy. The effort will be well worth it and besides—here's that "built it yourself" project you've been waiting for. A project that will not only give you that sense of accomplishment in building something yourself but will also add immeasurably to your operating pleasure.

Here is the list of component functions that I promised you earlier.

C1— Provides a hold for RL3. When Q2 conducts C1 will build up a charge. When Q2 is cut-off C1 will discharge thru R1 and RL3 and keep RL3 picked up. The length of time that RL3 will stay up depends on the setting of R1. The smaller the resistance of R1 the quicker RL3 will drop out.

C2— Keeps the receiver muted for a short period after the key contacts break. This prevents break clicks or thumps. The discharge rate of C2 and consequent mute time is controlled by the setting of R2.

C3— Bypasses CW side tone on minus six line to ground.

D5— Isolates RL3A from RL3B at the instant Q1 and Q2 are put into conduction. Provides a C1 discharge path thru RL3A as well as RL3B after Q1 and Q2 are cut-off.

D6— Allows a rapid cut-off time of Q4 when the key contacts open.

D7-D8— Make up a two legged "minus or" switch. A minus shift into either D7 or D8 will cut-off Q6.

D9— Allows the pick up of RL6 when S5 is in the 80 meter position as well when S5 is in the 160 meter position.

D10-D11—Prevent ringing in relay coils at the instant Q4 or Q7 in **Fig. 5** are cut-off.

I1— Lights when primary power is on.

I2— Lights when high voltage is on in amplifier.

J3-J5— Any device that switches to ground can be connected here. When one of these jacks is shorted to ground, with S3 in the send position, the control unit is put in the transmit mode.

J6— Provides CW side tone if S4 is on and one of jacks J3 thru J5 is shorted to ground.

J7-J10— Provide 110 VAC to station units (receiver, TR switch, etc.).

Q1— Allows a rapid pick of RL3. Normally cut-off.

Q2— Charges C1 to provide a hold up voltage to RL3 after Q1 and Q2 are cut-off when the key contacts open or VOX relay drops out.

Q3— Provides a minus switch voltage to Q4 and Q6. Q3 is normally cut-off and conducts when the key contacts close.

Q4— Keys the transmitter. Q4 is normally cut-off. Q4 conducts when a

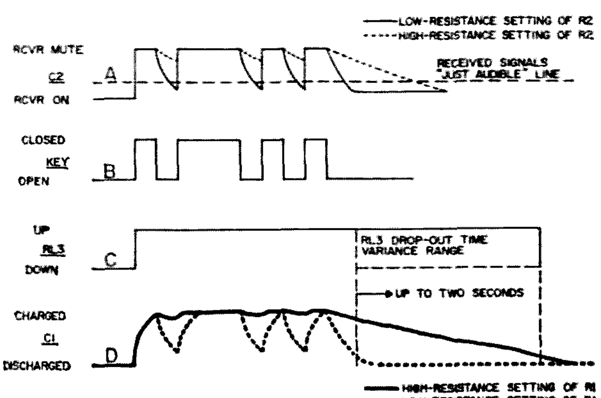

Fig. 4. Control unit timing.

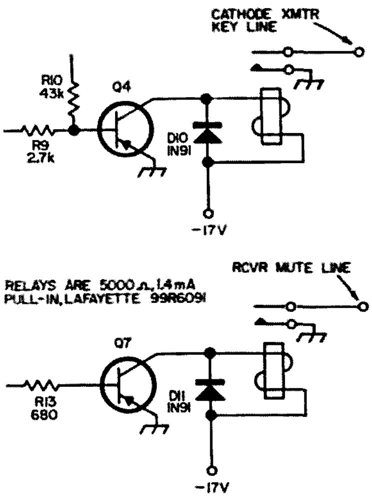

Fig. 5. Alternate key and mute circuits.

minus voltage is applied to its base thru D6.

Q5— Provides a minus hold voltage to Q6. Q5 is normally cut-off and conducts when the key contacts close. When Q5 conducts C2 developes a charge. When Q5 is cut-off when the key contacts open C2 will discharge thru R2 and R3. The time that C2 takes to discharge depends on the setting of R2. The charge on C2 will keep Q6 cut-off.

Q6— Provides a minus switch voltage to Q7. Q6 is normally conducting. Q6 is cut-off when either Q3 or Q5 conducts providing a minus input to D7 or D8.

Q7— Mutes the receiver. Q7 is normally conducting and is cut-off, muting the receiver, when the key contacts close.

Q8-Q9— CW side tone oscillator. July 1965 73 Magazine.

R1— Controls the length of time that RL3 stays up and therefore, how long the control unit will stay in transmitt mode after the last CW character has been sent or the VOX relay has dropped out.

R2— Controls the length of time that; the receiver will stay muted after the key contacts open.

R3— Prevents ruining of Q5 in the event R1 is turned to zero resistance.

R4— Prevents ruining of Q2 in the event R1 is turned to zero resistance.

R5— Sets power supply ground point. Should be set so that points A and B are of equal potential but opposite polarity.

RL1— Completes the circuit to the Variac, T2, which in turn applies primary power to the amplifier high voltage power transformer. RL1 picks up if S2 is on and RL3 picks up.

RL2— Connects the amplifier between the exciter and the antenna. RL2 picks up when S2 is on and RL4 picks up.

RL3— RL3 contacts pick up RL1 (if S2 is on) to turn on the amplifier high voltage supply and to pick up RL5 to connect the antenna circuit to the exciter or amplifier output circuits. RL3 picks up when Q1 and Q2 conduct.

RL4— RL4 contacts provide primary power to T1 and units connected to sockets J7 thru J10. RL4 picks up when S1 is turned on.

RL5— RL5 contacts connect the antenna circuit to the exciter or amplifier output circuits. RL5 prevents transmitter tank circuit signal "suck out" when in receive mode. RL5 picks up when RL3 contacts close.

RL6— Routes RF voltage to RL9. RL6 picks up when S5 is in either the 160 or 80 meter positions.

RL7— Selects the 40-20 meter trap inverted vee antenna. RL7 picks up when S5 is in the 40-20 meter position.

RL8— Selects the experimental antenna. RL8 picks up when S5 is in the AUX position.

RL9— Picks up when S5 is in the 80 meter position. When RL9 is down the pi network is connected between the 52 ohm line and 120 ohm Marconi antenna. When RL9 is up RF is fed streight thru to the Marconi antenna. (This Marconi matches 52 ohms on 80 meters).

S1— Turns on the control unit and supplies 110 VAC to the receiver, exciter, TR switch, etc.

S2— Turns on RF amplifier. S2 also switches the amplifier into the antenna circuit.

S3— In the "SEND" position allows the station to be put in transmit mode when the key is closed or VOX is operated. In the "STBY" position allows the CW side tone oscillator to be used as a code practice oscillator.

S4— In the "CW SIDE TONE" position gives side tone when the key is depressed.

S5— Selects the antenna to be used.

. . . W2AJW

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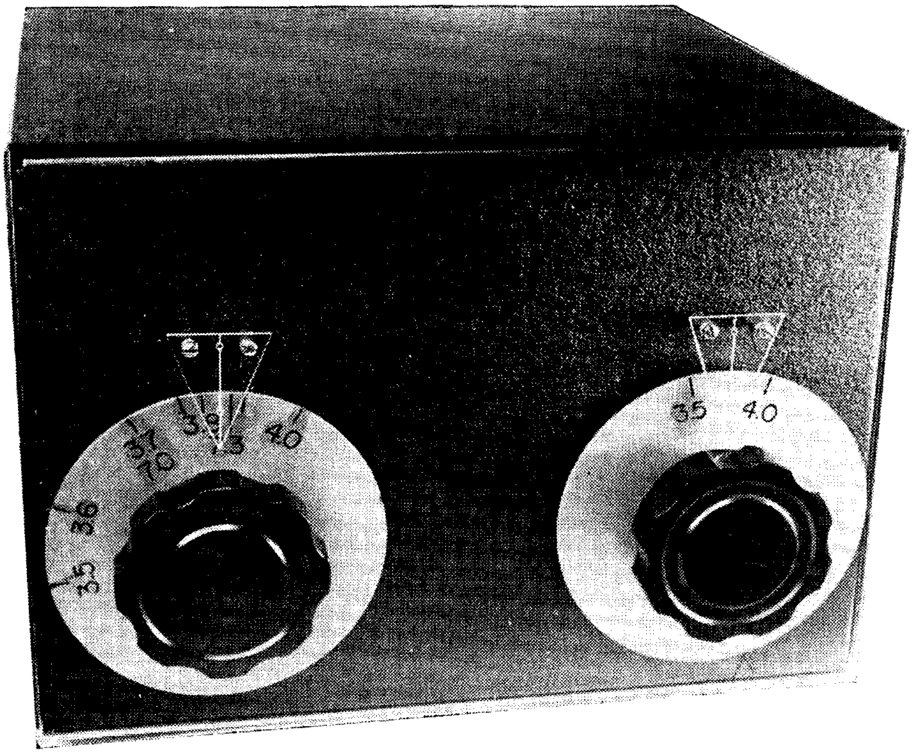

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Match Box Tuner

That Old Tuned Line

When I was young and in my prime
I used antenna tuners all the time,
But now that I am old and grey
I use coax the modern way.
I think I've strayed and find it's time,
I went back to that old tuned line
I went back to that old tuned line.

About thirty years ago most radio amateurs used tuned feeder lines in conjunction with an antenna tuner. Today just about all amateur stations use coax fed antennas, but some station operators are going back to the old method. Why? Until recently transmitters and SSB transceivers used large plate dissipation tubes in the output stage. If these tubes are overloaded they might get a little cherry red, but it did not seem to hurt them. Every one was happy, no problems, even if the rig was operated far from the resonant frequency of the antenna.

Today every radio gadget is smaller, and so are the tubes. Many manufacturers are using small TV sweep tubes in transceivers to keep the size compact. They hope the amateur operators using them have a flat antenna feeder line with no SWR (standing waves), and they also hope that he stays on SSB and does not hold the key down too long when tuning. The use of small tubes is based on the SSB operation with its low duty cycle, and that type of operation is not hard on the output tubes.

Just how many amateurs are using beams or dipole type antennas fed with coax today? Just about all of them, and how many of these have tuned the transmitter off from the resonant frequency of the antenna and taken a good hard look at the SWR and the color of the output tubes? The SWR does not have to go up in value very much before the rf begins to stay in the rig and be dissipated in the plates of the output tube rather than in the antenna.

Well, just what can be done about all of this faulty operation? Really there isn't a thing the coax fed operators can do about SWR except keep the rig looking into 50 ohms by a matching network, or change to an antenna that can be resonated to the operating frequency. The only reasonable way to use a resonant antenna is to go back to the antenna tuner and some type of antenna that can be tuned. Those operators who have fussed with antenna tuners in the old days will back away from the idea and shudder because it brings back

memories of trying to locate the feeders on the proper matching point on the tuner coil. This can be an exasperating job. However, the old timers can relax. The Johnson Company makes a gadget to replace tapping the coil. It is called a duo-differential capacitor. This capacitor when put across the coil acts as a capacitance tap, and in conjunction with the tuning capacitor keeps the coil in resonance. The old pain is gone. It's now easy to tune up the tuner.

The duo-differential capacitor is only made by the E. F. Johnson Co., and is generally not found in the catalogs or radio stores. It has to be ordered directly from the factory under the part number 169-25. When constructed the antenna tuner will handle 300 watts of CW or SSB on all bands, and maybe more depending on the insulation. Actually this match box is the same as the regular standard Johnson Matchbox but with modifications. The coil has been adapted to the Air-Dux coil in place of the specially wound Johnson coil which has a variable pitch in the center for the high frequency bands. The insulated switch shaft used by the manufacturer was also impossible to duplicate, and other arrangements were used to change bands. A battery clip fastened to flexible leads was used in place of a switch and worked very satisfactorily.

In this constructed tuner two separate coils were used. One coil tunes the 80-40-20 meter ham bands, another the 10-15 meter bands. Two separate inputs are used, as the link for the big coil is matched better with three turns, and the small coil with two.

To change bands the lid is lifted on the tuner box, the fahnstock battery clips are quickly pressed with the finger and moved to the taps desired for the proper band. The dial is moved to pre-marked settings for the various bands and slightly adjusted for minimum SWR.

As it turns out the maximum received signal on a receiver is just about the proper adjustment for the minimum SWR point when the transmitter is used.

For an all band antenna it is recommended that a 136 foot center fed zepp antenna be used if possible, with 600 ohm feeders about 45 feet long. Another suggestion would be to use 450 ohm manufactured feeders made from number 12 wire. Another suggestion is to use screw-in type electrical insulators for long runs of wire under the eaves of the house and pulling #12 wire through them and soldering tight. This method cuts down on the use of spacers except for the part actually going up to the antenna.

Construction

There is no special way to build the tuner. It is nice if it can be put in a box, but construction on just a chassis will be fine. The split-stator capacitor is mounted on metal studs to the chassis and the duo-differential capacitor is mounted on stand-off insulators. Two, 4½ inch lncite insulators are mounted at each end of the duo-differential capacitor to hold a ¼ inch thick by one inch wide lucite bar. Some long 4-40 machine screws with lugs were put in the strip to slip the band switching clip lead over when changing bands. The coil could have been shorted out when changing bands if separate coils had not been used, but in this construction the surplus turns are left floating rather than shorting them out.

Tuning

The transceiver output probably should be first tuned using a 50 ohm dummy load resistor to get the pi-network setting correct for 50 ohm output. The rig can then be connected to the tuner input. The tuner condensers can be varied for maximum signal strength, and then tuned for the low SWR indication which is between the tuner box and the transmitter in the coax link. When correctly tuned it should read very close to zero! Now you can increase the output power and are on the air. If a center fed zepp 136 feet long is used, operators will be surprised how much better signal reports will be over the old antenna especially when it is used on the higher frequency bands where the lobes begin to reach out. The main comparison from the long wire against the beam is that more noise is apparent on the zepp because it is not very directional. It is fun to switch from the zepp to the beam, there is not as much difference as one might suspect. It is also easier to use the center fed zepp for round table QSO's. I predict

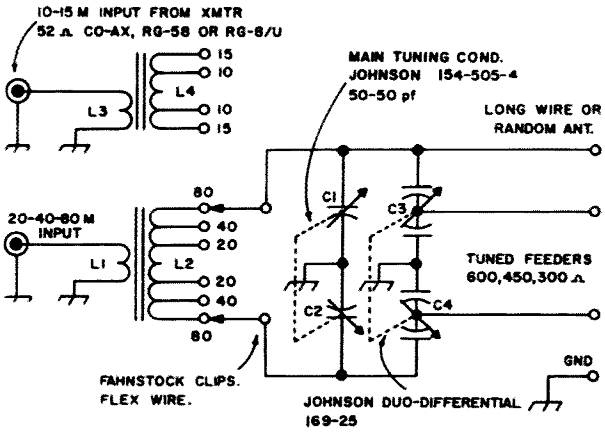
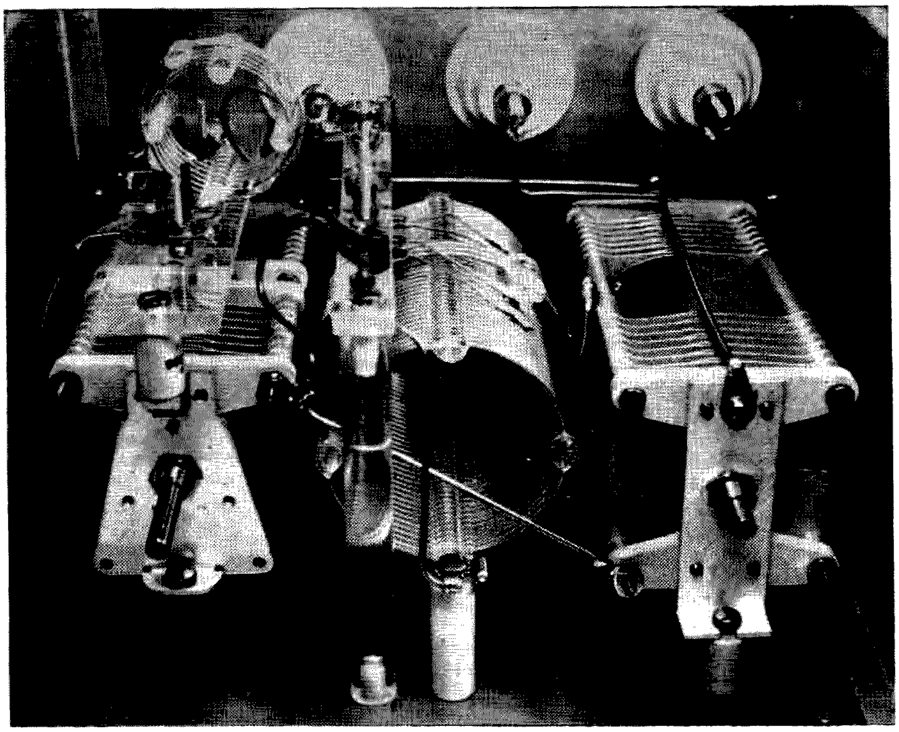


Fig. 1. W6BLZ's match box tuner. The coils should be shown os air wound.



Rear of the match box tuner.

in the future more amateurs will return to this ancient type antenna with the old tuned line.

General information

This tuner will match a 52 ohm coaxial line from the transmitter output into any line from 25 to 1200 ohms. For unbalanced lines it will match up to 3000 ohms making it suitable for using a long wire, or random wire antenna. The coupler is designed for antenna and transmission line matching and switching within the amateur bands from 3.5 to 30 MHz. A SWR indicator should be used between the coupler and the transmitter, inserted in the 52 ohm transmission line. The coupler cannot be expected to correct standing waves on the transmission line, which is a matter of match between the antenna and the line. The coupler will, however, properly terminate the coaxial line from the transmitter and match it to the transmission line terminal impedance. The link itself will have no standing waves on it. By doing this there will be a maximum transfer of energy from the transmitter to the antenna system and the tubes in the final will keep cool.

When the coupler is used with broad band antennas the tuning will cover the whole band with one setting. The system will become more frequently critical as the SWR on the transmission line is increased. If the resistance at the coupler terminals is too high for the range of the coupler, the line should be either lengthened or shortened until the capacitors inserted into the line correct for it. This might occur when a random piece of wire is used for an antenna.

. . . W6BLZ

Double Your Sixer Power

The power input of a Heath HW-29A Sixer can be doubled by a simple reconnection to the 6CL6 output tube and a change in tubes from the 6CL6 to a 7558. Components C8-10 pF and R4-47 k must be disconnected from pin 9 of V4 (6CL6) and re-connected to pin 2 of V4. The oscillator, doubler, and final tuning must be retuned when the 7558 is used. The cathode current should run about 60 mA compared to 30 mA for the 6CL6. The 12 V power cable filament jumper must also have the 150 Ω resistor replaced with a 50 Ω —1 watt resistor for mobile operation to correct for the higher filament current of the 7558. Improved audio can also be obtained by changing R-14 10 megohms to a 500 kΩ resistor located between pins 2 and 4 on V-B (12AX7). The pin changes to V4 permit the use of either the 6CL6 or 7558 interchangeably when used on 110 VAC. . . . K3QAY

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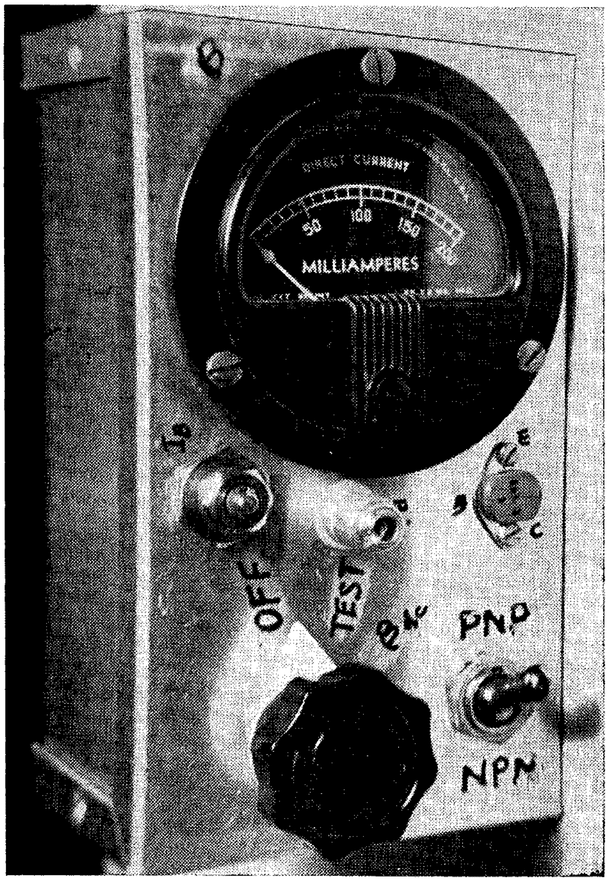
Two Transistor Testers

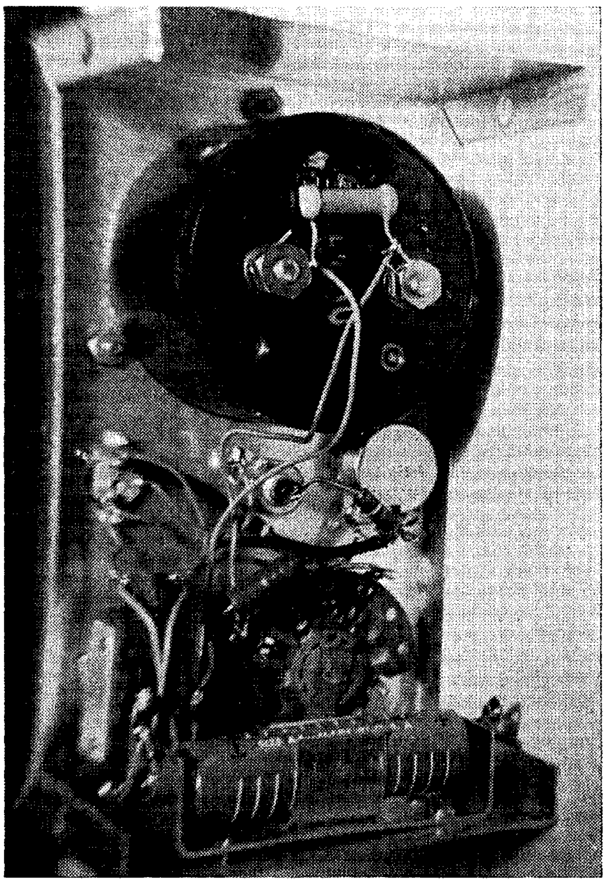
One of these two very simple transistor testers belongs in the shack of every up-to-date ham.

Two simple transistor testers are shown here both having the same basic circuit. The one shown in **Fig. 1** is about as simple as can be made for measuring the relative dc beta of either an NPN or PNP transistor. It was built into an aluminum box 3 x 5 x 2 inches with an old 0-200 Am meter. The latter had the internal shunt removed, giving a 0-2 Am meter with a 0 to 200 scale reading. A small half ohm resistor was shunted across it to make it read somewhere between 5 and 10 milliamperes full scale since most small transistors operate within this value of collector current. The exact reading is not important since the beta reading can be set to use the 0-200 division scale on the meter by adjusting the potentiometer in the bias circuit.

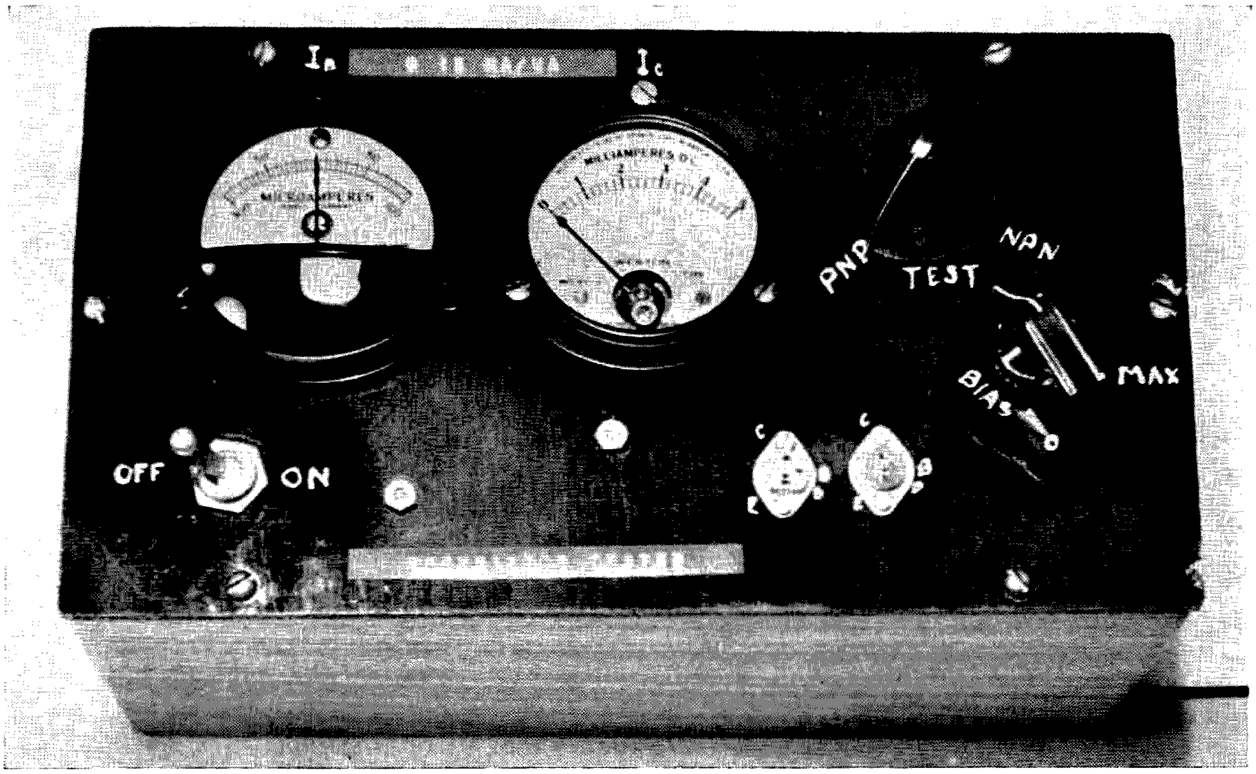
A battery and meter polarity reversing switch in **Fig. 1** is a DPDT toggle switch labeled NPN and PNP. By having a "test" position on the other switch, an unknown type of transistor can be plugged in for test without damaging it or the meter. The protective resistor should be 150 ohms for a 0 to 10 Am meter, or 300 ohms for a 0 to 5 Am meter in order to keep the meter reading to within



Front of the simple transistor tester in Fig. 1.



Inside of the transistor tester shown in Fig. 1.



Here's the front panel of the transistor tester shown in Fig. 2. Note the use of a zero-center meter for measuring base current. This avoids the necessity of using a meter-reversing switch there.

range even with a short-circuited transistor. If no reading is obtained with the NPN-PNP switch in either position, it indicates a very weak transistor or one with an open lead. Once these tests have been made, the dc beta can be read on the meter in the third position of the "test" and "off" switch.

The calibrating potentiometer can be set to read correct beta for a known type of transistor which has been measured on a more accurate transistor tester. The battery voltage affects the beta reading which means it should be checked occasionally to be sure it is near the 1.5 or 1.4 volt reading. The ordinary penlite sized cell should measure 1.5 volts and a single mercury battery cell should read 1.4 volts. Either type is suitable in this tester.

A more accurate type of dc beta tester is shown in **Fig. 2.** This tester was built into a larger box with two meters, one a zero center microammeter for reading the transistor base current for either NPN or PNP transistors without need of a reversing switch. The other meter, a 0 to 5 Am unit, reads the collector current for any particular value of base bias voltage and current. The milliampere reading can be set to any desired value such as 2 Am by means of the bias potentiometer knob. The reading multiplied by 1000 gives the collector current in microamperes. This value is then divided by the base current reading to give the dc beta of the transistor being tested. If the latter reading was 20 microamperes then

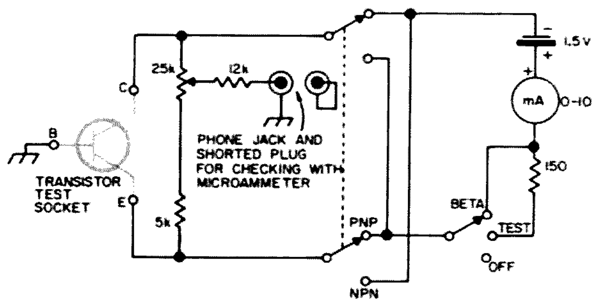


Fig. 1. The simpler of the two transistor checkers described by W6AJF in this article. The proper scale can be set by adjusting the potentiometer.

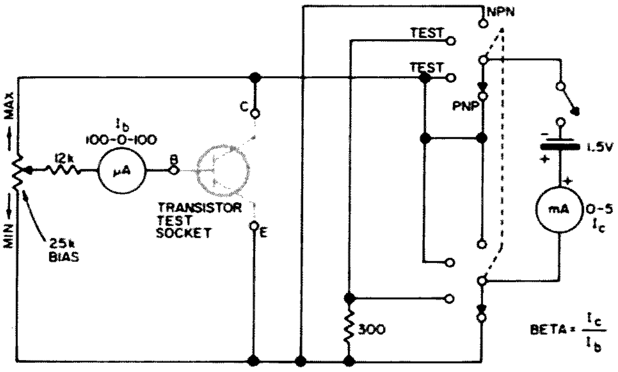
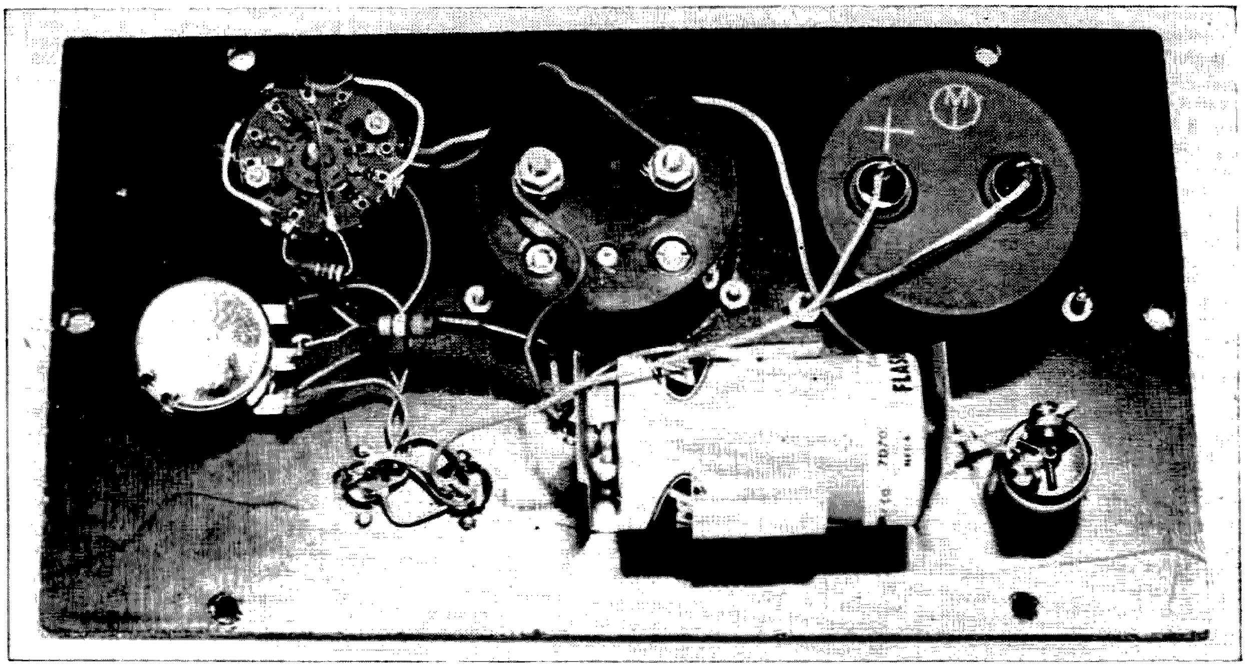


Fig. 2. The more complex of the two simple testers. You can figure the beta of the transistor under test more accurately with this tester than the one in Fig. 2 since you get a specific collector current for each value of base current you use.



Back view of W6AJF's transistor tester as shown in Fig. 2. The circuit is very simple and construction is completely non-critical. Either a mercury cell or a regular flashlight battery (shown) can be used.

for our example the beta is 2000/20 = 100.

The PNP-test-test-NPN switch is a DP4T wafer switch. Two test positions were used with the 300 ohm protective resistor inserted series with the meter to prevent burnout for the case of a short-circuited transistor. Another protective resistor of 12,000 ohms was connected in series with the base circuit microammeter in case of a faulty transistor. A single flashlight battery was used to power the tester.

In testing either NPN or PNP transistors the current of both meters should increase simultaneously as the bias is increased from 0 towards maximum. If such is not the case, try the other switch position PNP instead of NPN or vice versa. If the beta reading is too much lower than transistor handbook values listed for "hfe" for a given type of transistor, it should be discarded. Higher valeus generally mean that you are in luck, as the transistor has a higher dc beta and hfe than the average units.

These testers do not measure anything except the relative efficiency as a dc device. It does not show up noisy transistors or give any indication of the operating frequency range. However, if it tests good on dc values, the transistor will probably work well in the frequency ranges listed in transistor handbooks.

. . . W6AJF

De-Bugging the Hi-Fi

Nothing can be more frustrating than a case of interference, particularly when the station is not at fault. This case involves a Hi-Fi system that would emit from the speaker, with ear-shattering intensity, the unintelligible single-sideband signal whenever the rig was used on twenty meters.

The accepted method of using capacitors to by-pass the grids and speaker leads resulted in little improvement. The frustrations involved in locating the elusive bug are unimportant but the specific cause is worth mentioning. After all, it could happen to you.

The final cure was the use of a capacitor from one side of the volume control to the chassis. According to the schematic this point was already grounded. After another careful examination of the amplifier, the cause was quite apparent.

As in many of the better amplifiers, this one did not ground directly to the chassis but used a ground buss, running from point to point before being tied to the chassis at only one location. The extra foot or so of wire from the volume control to the chassis was an excellent ground for the audio and, at the same time, did a pretty fair job as an antenna. Eliminating the rf at the volume control cured this particular source of interference.

. . . Ronald Farren WAØBGQ

Gary Jordan WB6MOC
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ITT Federal Laboratories
San Fernando, California

The Transistor for Voltage Regulation

Here's a voltage regulator that puts out 9 to 28 volts at up to 10 amperes with excellent regulation.

In many instances the amateur is interested in using or adapting a circuit using transistors, only to find that he has no means for supplying properly regulated and filtered power. Unlike the vacuum tube, which is relatively insensitive to minor voltage excursions and ripple in dc, the semiconductor demands a stable supply source and negligible ac in the dc to give optimum performance.

A change in bias voltage of 1 volt on a vacuum tube usually has very little effect upon the tubes operation. A one volt bias change on a transistor however is usually disastrous. One volt can mean the difference between class A and class C operation, or possibly no operation at all.

Gary has been W3AEX, W8LWL, WAØEFT and K1FPM. He's an electronics research engineer with a BSEE from Ohio and an AMIEE pending.

Circuit theory

The circuit of **Fig. 1**, is a rather standard series voltage regulator in the commercial field but needs a bit of explaining here because it is rather rare in amateur usage.

The easiest way to understand how the circuit works is to imagine the series transistor Q_1

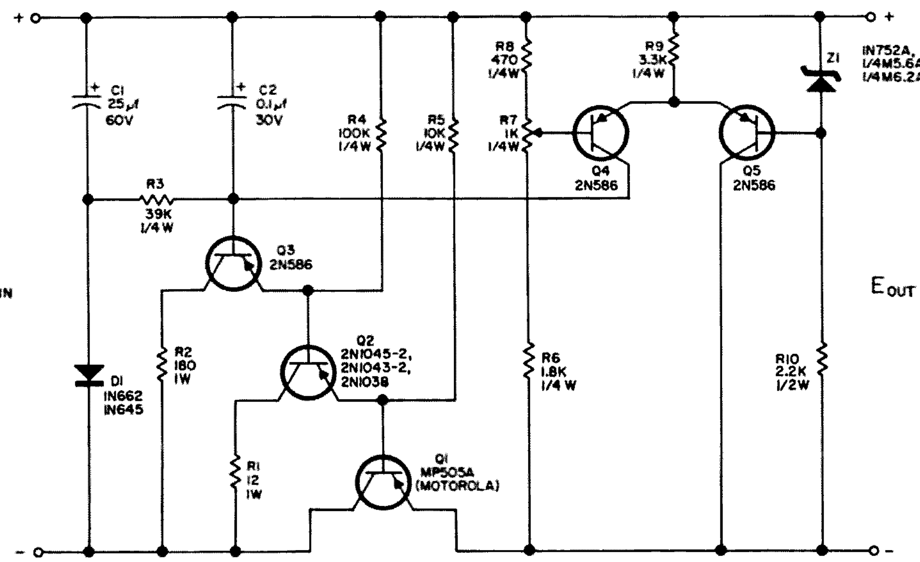
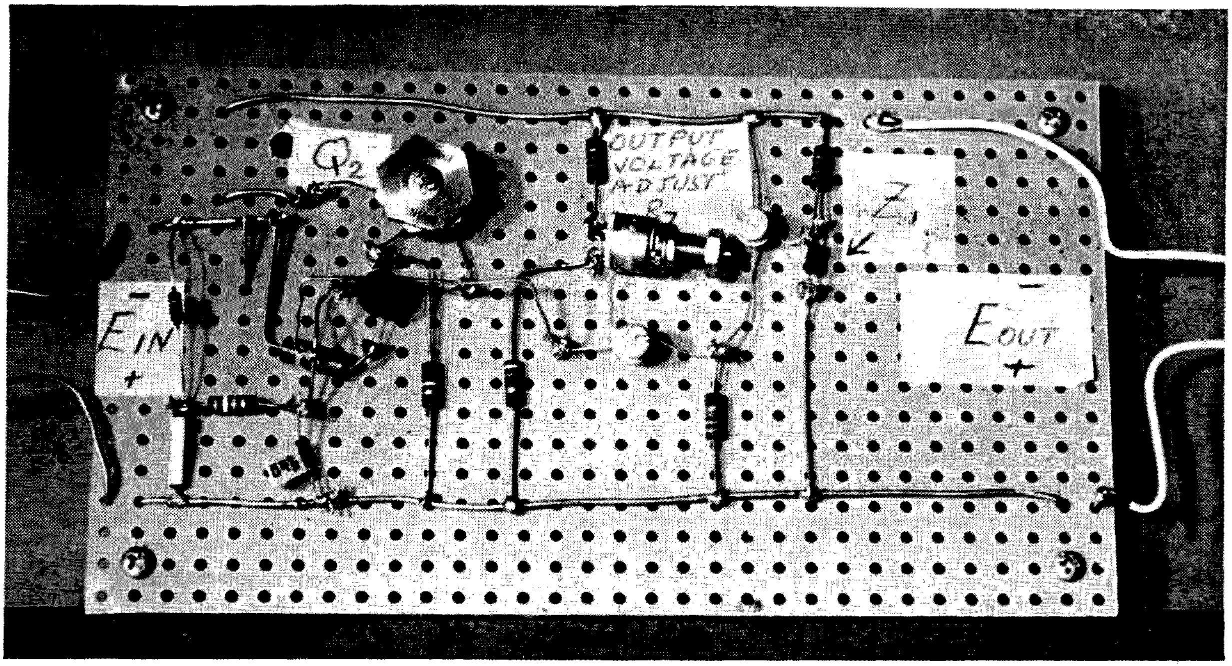


Fig. 1. Transistor regulator for 9 to 28 V output at up to 10 A. You can omit Q1 for a maximum current of 3 A.



Breadboard of the regulator shown in Fig. 1.

as a variable resistor that is automatically controlled. If the input voltage E_{in} were to increase, or the current being drawn by a load at E_{out} to decrease, the resistance across Q_1 must increase to keep the voltage at the E_{out} terminals constant. Similarly, if the load current goes up then the resistance of Q_1 should decrease to keep E_{out} fixed.

Now we might want to draw quite a bit of current through Q_1, maybe as much as 10 A. Since the current required by the base of Q_1 is approximately the current through the transistor divided by its amplification factor B (which may be any where from a value of 10 to about 30) a bit of dc amplification is in order. Q_2 and Q_3 provide this implification in a so-called Darlington configuration. Darlington circuits are simply those that hook the base of one transistor directly to the emitter of another, providing a very simple means of increasing gain. In effect, the gain, or B, of Q_3 is multiplied by the gain of Q_2 which is multiplied again by the gain of Q_1. Thus a very small current at the input of Q_3 can control very large currents through the series transistor.

Now all that remains is to provide some sort of feedback network which will sense the output voltage and control the series transistor. The sensing of the output voltage is done with a simple resistor string across the output, in this case the $R_{6\text{-}7\text{-}8}$ string. Also, we need a stable voltage source as a reference, and you will note a simple zener diode does the whole trick admirably here.

With the zener providing a good stable reference we can now compare the output voltage to the reference and make the series regulating transistor "take up the slack." This is accomplished by a simple differential amplifier, of which the operating theory is adequately covered in most transistor manuals.

If you've made it this far you should have a fair idea of how the gadget works, so now to the easy part, the "makings."

Construction and operation

The circuit shown can provide any regulated output voltage from 9 through 28 volts. The value of E_{in} is best selected as 25 to 50% greater than the desired output voltage, E_{out}. The input voltage can be easily obtained by a simple bridge rectifier and single capacitive filter, as shown in Fig. 2. With Q_1 in the circuit, a 10-A load current may be drawn continuously. Omitting Q_1 and connecting Q_2 in its place allows 3 A maximum.

Both Q_1 and Q_2 should be mounted on a suitable heat sink, such as a chassis, with an area of 20 square inches or more. Use the insulating material supplied with the transistors to keep the cases electrically isolated from the chassis, as the collectors are connected internally to the case.

Use the value of capacitors specified; they provide proper time constants for regulation and for damping feedback oscillations that can occur.

The output of the regulator should not be

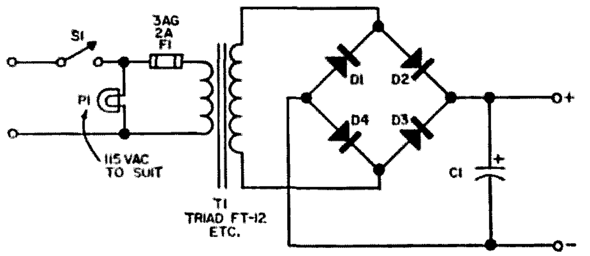


Fig. 2. Power supply for the regulator in Fig. 1. D1 through D4 can be 1N538 for values of C1 below 2000 μF or 1N2610 for larger C1. C1 should be as large as possible and rated at 60 to 75 V.

short circuited even if a fuze is used in the transformer primary supply, because either Q_1 or Q_2 may exceed current ratings and fail before the fuze opens. A more advanced version of this circuit would include some provision for current limiting. Other than these restrictions, the circuit can be built in any reasonable configuration and will work quite well. Output voltage can be easily set and adjusted by adjusting R_7; once set, it may be forgotten or varied at will.

Use of the circuit

Similar regulators have been built and used with excellent results. Specifications and requirements for professional uses far exceed those needed by amateurs, yet the cost of this circuit is now reduced to its most economical form without sacrifice of good characteristics.

Amateurs should find this circuit quite useful, because either side of the output may be grounded, and regulation and ripple reduction are such that a home laboratory or equipment supply is as feasible as the more common vacuum tube B+ supply. . . . WB6MOC

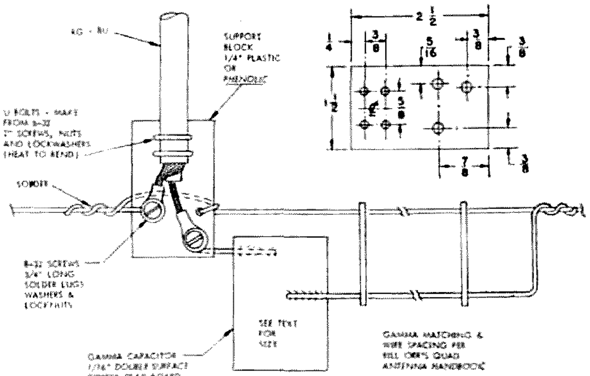
Improved Gamma Match

Prior to constructing my homebrew tri-band quad I had concluded from on-the-air discussions that a gamma match was a mighty good investment but was somewhat complicated due to problems in waterproofing the large air-gap gamma capacitors.

After giving the matter considerable thought, the following relatively simple approach was developed and has been used very successfully at this QTH.

Bill Orr's Quad Handbook gives dimensions for gamma rod spacing and length; however, in lieu of air-gap variable gamma capacitors simple fixed capacitors were constructed from 1/16" thick double surfaced copper printed circuit board material.

First, a separate gamma match assembly was constructed for each band per Bill Orr's dimensions as shown in **Fig. 1** except that a small variable capacitor was temporarily substituted for the printed circuit boards and the support block was added. Capacitors can be 150, 100, and 75 pF for 20, 15, and ten meters.



The transmitter (use low power 200 watt type) was then tuned for 14,300, 21,300 and 28,600 kHz and each capacitor was adjusted for minimum SWR.

The capacitors were then carefully removed without changing their settings and the capacitance of each was measured. Printed circuit board material was then cut with a hacksaw to slightly larger values (+5 pF) and edges bevelled as shown using a small wood rasp. These were then soldered into place and the SWR was again checked on each band. The boards had to be cut down slightly using a pair of dikes or tin snips to achieve minimum SWR. Plastic tape was wrapped around each board and VOILA!—we had a light weight weather-proof gamma match.

If you want to gamble and avoid the variable capacitor substitution method the following sizes will be more than enough and can be easily trimmed on the spot to give minimum SWR.

Band	PC Board Gamma Capacitor	
20 Meters	1½ x 3"	Approx. size
15 Meters	1½" x 2"	" "
10 Meters	1" x 1½"	" "

Two separate feedlines should be used, one for 10 meters and a common 15-20 meter line or three separate lines may be used.

. . . W. H. Paxton K6ZHO

Bill Hayward WØPEM
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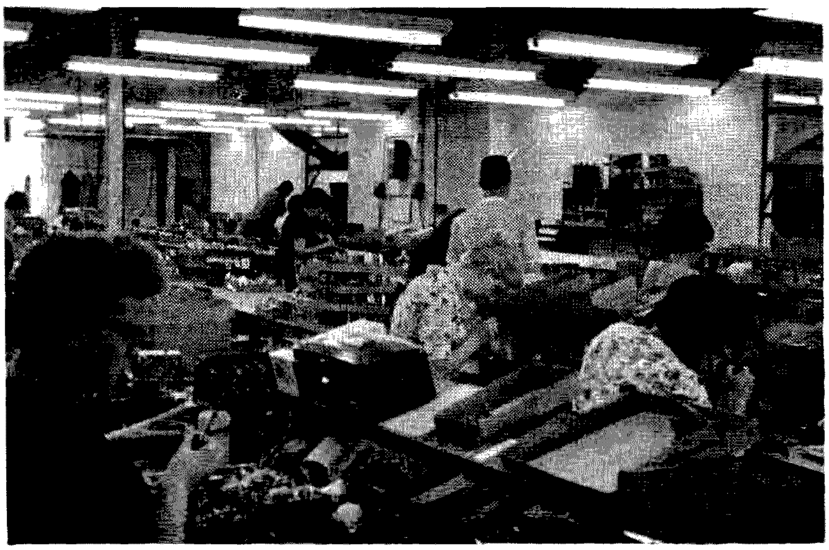
I recently found myself in Miamisburg, Ohio, home of all that good Drake gear, so thought I'd drop in for a visit. I found their building, was warmly received and shown around by Peter Drake.

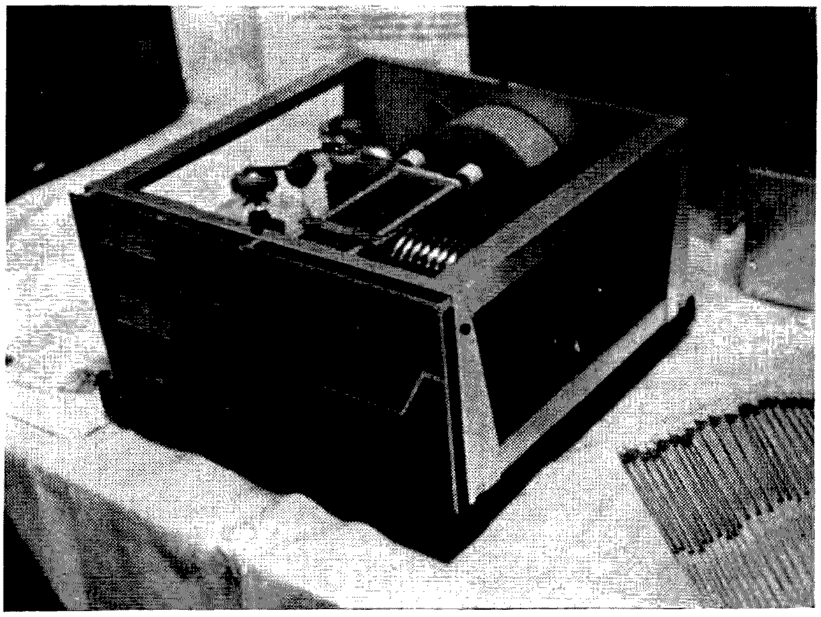
A Visit to the R. L. Drake Company

Here is part of the Drake production line. Drake only makes ham gear and TVI filters.

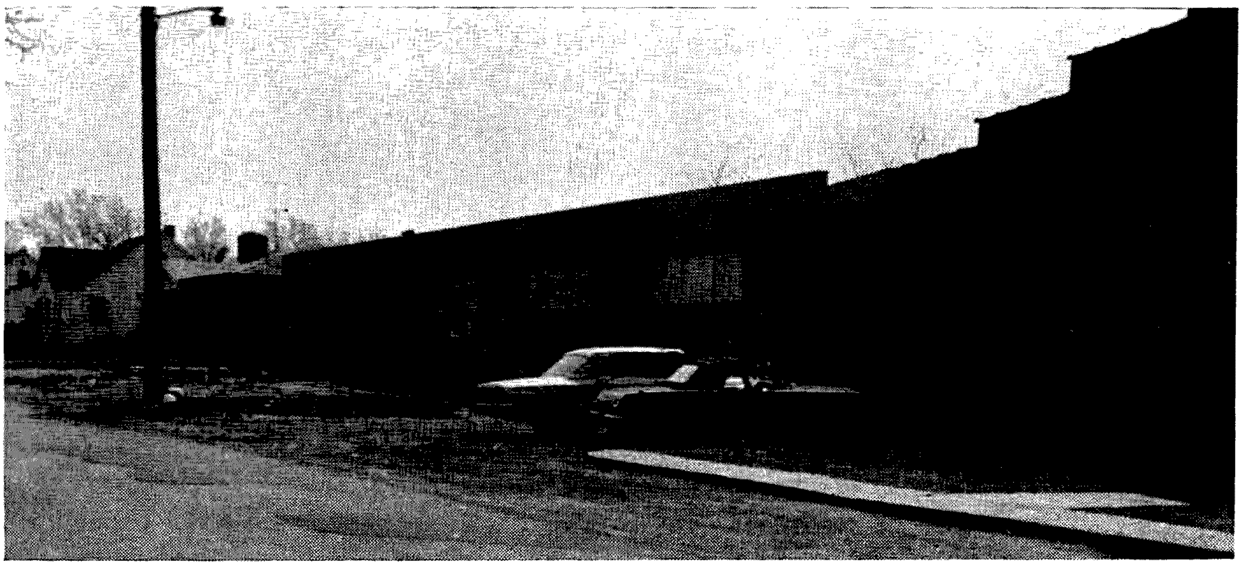


Here's more of the production line. The engineering department and metal work are in another building.

Here are some of the new products shown at the Dayton Hamfest: The 2-NT CW transmitter and the 2-C Ham band receiver. Another product they make is the SW-4 short wave broadcast receiver. Watch for details in 73.



The new Drake L-4 linear offers 2000 watts PEP—1000 watts DC. Tubes are two Amperex 8163's. Price with separate power supply and tubes is under $700.



Here next to the Drake factory is the new addition they've been working on. Business is good. Also notice Bob Drake's Triumph. I enjoyed my visit with Drake. I'm sure you would, too.

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Try Homebrewing Now

When I sit around a swimming pool, I'll notice three groups of people: there is one group that stays around the pool, soaking up sun but never getting their feet wet; another group that dives in, discovers that the water is cold and runs out again; and a final group that edges into the water slowly. These people usually have the most fun and stay in the longest time.

Ham radio homebrewing has the same groups. Some never bother to homebrew; they sit home, their pudgy fingers glued to a knob, praying that a tube doesn't go. On the other hand, some guys buy up their local electronics store and try to build an imitation NCX-5 before they have learned how to solder. Finally there is a group that thinks about building, works on it carefully, stays in the longest and has the most fun. This is the group to join.

How, you say. How can I "edge in" to homebrew? Tools cost, and besides the thing will probably do nothing more than exude black noxious fumes when I plug it in. But this doesn't have to be so. It is easy to get started in homebrew without money, parts, or even tools.

No tools? Most—if not all—towns have a ham with a set of chassis punches and drills. Being a homebrew fan, he'll be glad to help out and get another convert. Seek this man out and swipe a weekend of his time. Hams are notorious for their brotherhood; use it.

No parts? Old TV's, radios, tuners, anything electronic will furnish parts. The best thing to salvage is a good power supply. Again, most hams in any reasonable sized town have an overstuffed junk box. Grub a few parts from them and you won't have to spend more than five dollars a project. If you load yourself with catalogs and flyers (Say you saw it in 73) you'll be able to save money to the point where you'll feel sorry for the manufacturer. Parts? No problem.

No money? A five dollar bill will take care of preselectors, Q-multipliers, a VOX, full CW break-in, a code monitor or two, a noise limiter, a product detector, a crystal BFO . . .

I could go on forever. And how do I know? Either I or a friend has built one of the above items for a five dollar bill. Don't say it can't be done.

By now, hopefully, you see that all the myths about the great expense, great labor, high rate of failure, etc., are a lot of pap. Armed with this knowledge, you desperately go searching through your old back issues of 73 in order to find that six-meter converter you never had guts enough to build. But let us suppose that you are a hard-core cynic who still believes that homebrewing is for the birds. Here are a few reasons why homebrew pays.

First of all, satisfaction. Big deal, you say. Well, if you don't care about the personal satisfaction involved, read on. But it means a lot to a lot of guys.

Second of all, you can own equipment that no manufacturer could supply. Who is going to produce a product detector that you can put in your old decrepit receiver? That, believe me, is a limited market. Where are you going to get hundreds of accessories? The only way you can get them is by homebrew. That, I think, is one of the best reasons.

You learn a lot. Big deal again, you say. You say you don't need to learn; you simply push a button and you're on the air. Yeah? What happens when your receiver kicks out? Try sending your 105 lb transceiver back for servicing. And have fun packing it.

You save money. How much money? To get off ham matters, I know a guitar-playing friend who paid forty dollars for a fuzz-tone. A ham friend copied the schematic and built one for ten dollars. In most cases of homebrew there's nothing to compare it to since there are no equivalent units available. But look up the price of a VOX and see how much it would take you to build it, using the techniques of sophisticated grubbing mentioned before.

If you haven't tried homebrew, start edging into the swim of things. In a while, it'll get mighty hot for the boys sitting around the pool doing nothing. Get a head start on them.

. . . WB2JQC

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Freeville, N.Y.

Diodes for Oldtimers and Beginners

A few simple games help explain electron current in a vacuum, wire or semiconductor.

One evening a venerable oldtimer presented me with a problem. He said, "If a diode conducts with the anode end plus, why does the cathode end carry the plus sign?" I said, "That's the end that goes plus." He replied, "It has to be minus." Round and round we went, and it turned out to be quite a problem. I finally had to write this article to clear it up!

What's confusing about such a thing? From a practical viewpoint, diodes are too simple to raise serious questions. But the problem is not diodes, it is words. We say a current flows this way, or that. But which way does it *really* flow?

About 1747 Ben Franklin believed electricity flowed from plus to minus. It was the best opinion available in his day. In 1891 the researchers just starting atomic physics had found some puzzling things, for which the Irish physicist Johnstone Stoney (three cheers, etc!) suggested the term 'electrons'. Finally, in 1895, J. J. Thompson showed that electrons really exist. This should have settled the matter permanently.

But the plus-to-minus convention is still with us. And in some semiconductors it is correct! We call it hole current. I'll tell you something if it won't see print: I'm still confused sometimes.

The best way to avoid this confusion is to get past the terms, right down to a clear picture of what actually happens inside conductors and diodes. Three games, described later, will help to make this picture clearer. You'll get the most from them if you read from the bibliography about some of the things I left out to make the games simple.

Diode current

What the old-timers called just plain current, back around World War II and earlier, I'll call electron current. This absolutely eliminates the question of which way it goes, because we can tell any time by thinking about vacuum tubes. But how many electrons are actually moving when an electron current is flowing? If you use an ammeter, the magic number is 6.3 billion billion electrons per second per ampere!

The vacuum tube not only tells us which way electron current flows, it supplies the simplest picture. The cathode serves as a source of electrons. The anode takes them out of the picture again and not very much happens in between. This is the first illustrative game, the Diode Game.

Fig. 1 shows what labels are required. This is marked out on a piece of paper which is then attached to a board or book and tilted as indicated. Marbles or pennies will do for electrons. Drop them at the cathode end and watch them exit at the anode end. You may feel stupid, but do it anyway. The important thing is to get into your bones the idea that something like this *really happens* when a current is flowing in a vacuum diode.

Wire current

All electron currents flow in a vacuum! From the electron's viewpoint, the interior of a wire is mostly open space. The atoms are well separated, and serve partly as a source of electrons for conduction. Is that a little hard to believe? It took thousands of years to discover this fact, and even now practically nobody appreciates its truth or value.

Because the wire's interior isn't quite all open space, wire conduction differs from vacuum conduction in two ways. In the first place, the electrons travel within the wire in relatively straight lines. Sooner or later each will collide with an atom. That's the end of its trip, which is taken up by another electron. And each time an electron comes to a sudden stop, the atom is slightly warmed.

That's why wires get hot if they carry enough current. This knocking about, recurring billions upon billions of times per second, heats the wire. The result is very useful in vacuum tubes, not so desirable in transistors.

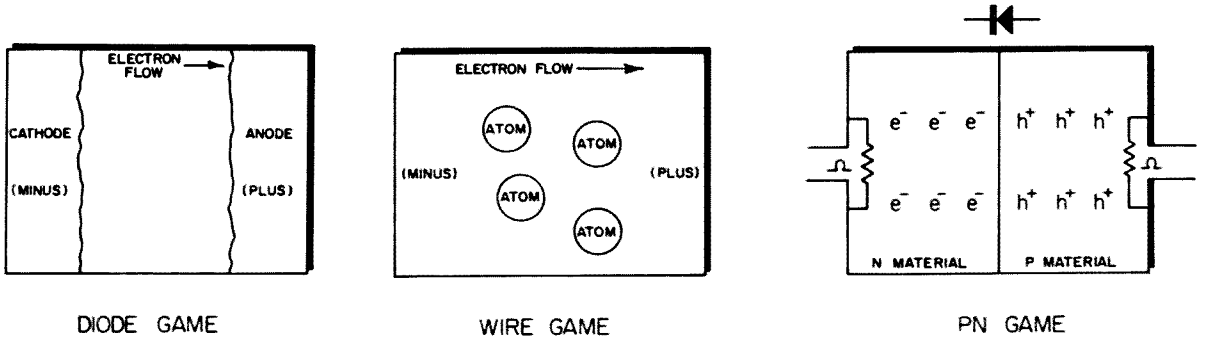

Fig. 1. W2DXH's three games illustrates what really happens in vacuum tubes, wires and PN junctions as electrons flow from one end to another. The games are explained a bit more fully in the text.

There may be some question of how many electrons belong in the piece of wire. Of the various answers, the simplest is: as many must leave as enter. This preserves the electrical balance of the wire, which in a more elaborate explanation is not necessary. Leave this problem 'til later!

You might try working out a game to illustrate wire current. But if you want to copy mine, refer to the Wire Game chart in **Fig. 1.** It resembles the Diode Game chart, but cathode and anode are omitted and some atoms have been added.

The atoms are physical obstacles pasted to the paper. Bottle caps will do admirably. One end is labeled minus, the other plus, the sheet it tilted with the plus end down, and you can start sliding electrons down between the atoms.

Remind yourself that if an electron strikes an atom, it sticks and another continues the journey. The atom gets warmer. And as you watch things go, think about those big numbers, amounting to millions of millions of electrons moving for each microamp of current!

PN junction current

Solid state conduction resembles wire conduction. But there are two kinds of solid state conduction. Both require that the material be crystalline, and that it be doped with carefully regulated amounts of impurities. The type of conduction depends on the impurities chosen.

The first type of solid state conductor, N type material, depends on the presence of impurities with extra electrons. If there is no such impurity, the electrons in the crystal will be all tied up holding it together, none available to move as a current. Conduction in N type material closely resembles wire conduction.

P type material is doped with an impurity having too few electrons. As a result, many sites within the crystal should, but do not, contain electrons. But they can get electrons from other regions in the crystal. If a hole captures an electron, the hole and electron seem to trade places.

The sequence of events is best explained by going on to the PN game in **Fig. 1.** From left to right across the drawing, we have a piece of wire entering the diode, an ohmic, or bidirectional contact between the wire and N material, a PN junction between the two types of semiconductor, another ohmic contact between P material and wire, and finally a wire leaving the idode.

If we push an electron into the LH wire, electrons will be displaced along the wire and shortly one will cross the ohmic junction into the N type material. But since the N conductor is already balanced, another electron is pushed over the PN junction into the P type material, where it promptly falls into a hole. The P material, unbalanced, kicks an electron across the ohmic junction into the RH piece of wire. And our electron, many times removed, continues its journey. This is a forward conduction process.

Suppose, now, that we push the electron into the RH wire. With a little urging (reverse bias) it crosses the ohmic junction and falls into a hole, leaving the entire region charged slightly negative. No electrons from the N region are interested in stepping into this; in fact they will retreat a little way from the PN junction. A similar event occurs if an electron is removed from the N region. This is the fundamental process of reverse biasing.

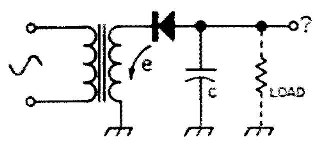

Fig. 2. W2DXH's transformer and diode problem.

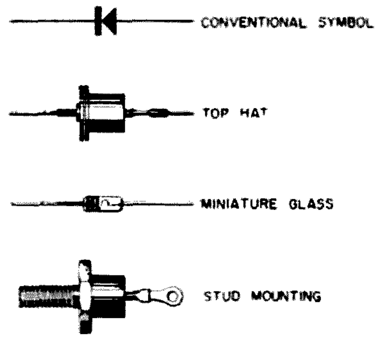

Fig. 3. Some kinds of diodes that we often use.

Diode circuits

When these games have been played out, the diode problem should be clearing up. Just to make sure let's look at a simple diode and transformer circuit (**Fig. 2**) and watch its operation through a single cycle.

The diode is drawn in the same orientation as shown in the PN game diagram. We immediately know that electrons will flow from left to right but not from right to left. If we look at the transformer as a device which tries to sweep electrons through its secondary first one way and then the other, everything works out promptly. The slightly curved arrow indicates which way the transformer tries to sweep electrons in the first half-cycle, and a letter "e" is placed by it as a reminder. We see right away that no electrons flow during the first half-cycle. They flow against the arrow of the diode, so during the second half-cycle, electrons swept the other way pass through the PN junction and collect in the capacitor. After one or a few half-cycles of conduction the capacitor has developed enough charge so that no further current flows, except that through the optional load resistor. Try to work this out for yourself.

We get exactly the same final result if the current is assumed to flow from plus to minus. But then the diode seems to conduct in the direction its arrow points, and it appears that positive charges have been removed from the capacitor, rather than negative charges collected there. Have you ever read Orwell's "1984"? Well, here's a good example of something like this "double-think." When you've caught the trick, try it out on the best man you know. You just might surprise him!

. . . W2DXH

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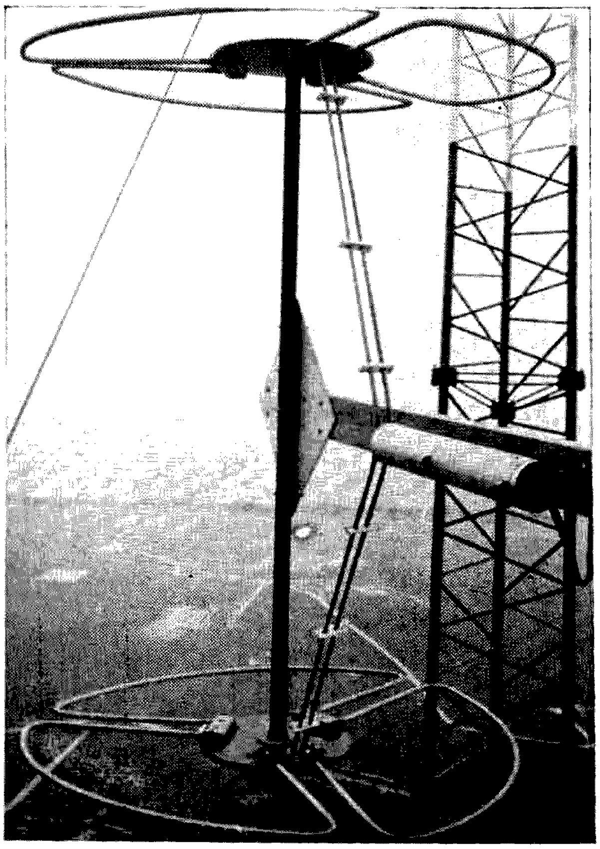
Two Meter Repeater

This repeater offers very wide coverage for fixed or mobile.

As more stations are moving up into the two meter band, a desire to increase their reliable range has caused many to look toward the repeater as an answer. This is a story of just such a repeater that was built by Air Force MARS people from surplus military and commercial FM equipment. Outmoded FM equipment was used because of the large amount available from commercial users. No effort will be made to endorse any piece of equipment as this is what we used and other gear could probably be used just as well.


The transmitting antenna with coax balun as it looks on the 1400 ft. tower also used for KPRC-TV.

As can be seen in the block diagram, **Fig. 1**, the receive and transmit frequencies are separated by only 490 kHz. The methods used to prevent the receiver from being desensitized by the transmitter are little known to hams and should prove interesting to other amateurs who are plagued by strong carriers near their operating frequency. A cavity transistor preamp has been added to the receiver and can be placed on the tower to make up for the loss in a long transmission line.

This repeater was developed to receive on 143.46 MHz and transmit on 143.95 MHz, Air Force MARS frequencies just below the two meter band. Although these are not amateur frequencies the information supplied here has been used by amateurs using repeaters on 146.94 MHz. Different crystal frequencies are the only changes necessary to operate in the two meter band.

We used a surplus FRC-27; however, the TRC-34 and VRC-19 are very similar. The FRC-27 and TRC-34 are ac powered units and are almost identical. The VRC-19 is a mobile unit designed for a 28 V electrical system so would need an ac supply.

The block diagram (**Fig. 1**) shows the complete repeater. It will be noted that the companion receiver R-394-U is not used. It was very unreliable. A GE Progress line 4ER25D was modified and substituted to give very reliable performance. This wide band receiver is expensive to narrow band so is available at very low cost.

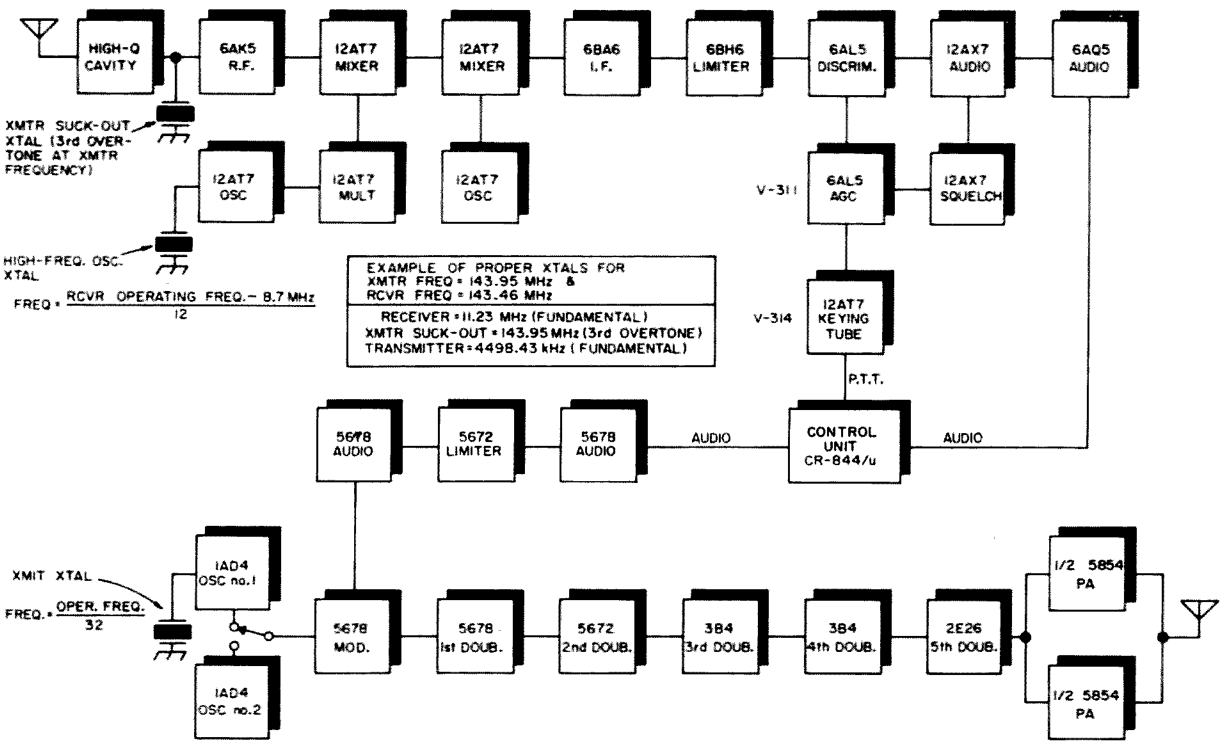


Fig. 1. Block diagram of the 2 meter FM repeater described in this article. The transmitter is a surplus unit from the FRC-27 and the receiver is an out-dated GE wideband commercial receiver.

Transmitter Adjustment

The transmitter is coded T-416-GR and is installed in the lower right compartment. This unit uses instant heating tubes up to the driver, so only two tubes draw filament power during stand-by. The 5894 final operates in a very efficient push pull circuit and is capable of about 70 watts output. This unit uses a crystal multiplication of 32 times. The crystals shown are for either the 146.94 MHz or 143.95 MHz frequencies. These crystals should be in the HC-6U holder to take advantage of the ovens in the units; however, a FT-243 may be used if the oven is not desired.

A test card CX-2371U to allow removing the transmitter from the cabinet was found with some units; however, several have been made by using surplus connectors. A VTVM is used for the tune-up. Insert a crystal into the socket and switch transmitter to tune. Do not operate the transmitter for longer han 10 seconds until the final has been tuned. Remove both side covers and note the test point marked J401, etc.

Turn on the unit and allow time for the final and driver to heat. Switch the frequency select switch to the socket which has the crystal in it as this is a two frequency unit. The transmitter is keyed by turning the test switch to on. The switch should be returned to the off position as stages are tuned and the meter is advanced to each test point. Place a 50 ohm dummy load on output jack P1902.

Tune up as follows:

VTVM connected to	Adjust	Indication	Reading
J-401	Z-401	Max	−5 V
J-402	Z-402	Max	−23 V
J-403	Z-403	Max	−30 V
J-404	Z-404	Max	−70 V
J-501	Z-405 C-502	Max	−40 V
J-502	C-507 C-508 C-509	Max	−45 V

Insert the VTVM in J-505-506 PLT CWR JKS. (Caution: HV to ground is present on these lugs). Adjust C-514 PA tune condenser for a dip on VTVM. Now load the PA to

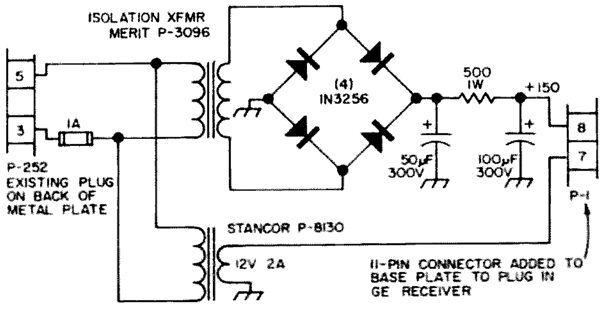


Fig. 2. Receiver power supply for the repeater.

about 200 mA as indicated by a 2 V reading on the VTVM. After each loading adjustment is made adjust final plate tune for minimum.

Insert VTVM in BAL JKS and alternately adjust PA grid tune for balance as indicated by zero reading VTVM. The transmitter should be putting out about 30 watts. Placing the tune-operate switch in the operate position should allow the transmitter to put out full power.

Receiver Conversion

The receiver supplied with the FRC-27 is the R-394-U. This receiver has been the greatest single cause of unsatisfactory performance in the repeater, and was finally discarded in favor of a more reliable unit. The receiver found more adaptable was the G E progress line 4ER25D. This is a double conversion unit built in two models. The 4ER25D1 will cover 144 to 152 MHz and will operate in the two meter band with no modification to the tuned circuits. The 4ER25D2 operates in the 152 to 174 MHz range and will require a 5 pF capacitor connected across the first RF and antennas coils.

The B-394-U chassis should be stripped of all metal work leaving only the base and upright back plate. All wiring and plugs are removed except for P-252 on the rear plate. The receiver is mounted on its side supported by 2" spacers as shown in the photograph. The power supply and filament transformers

Two Meter Cavity Preamplifier

Here's a high-Q cavity and transistor preamplifier to add selectivity and gain to the front end of your receiver. The cavity has about 20 dB of gain and is very useful if the repeater is located very far from the antennas. It can be seen that the junction of the transistor will look like a very low resistance to any power coming down the receiving antenna, and were it not for the cavity filter the transistor would be destroyed by the rf from the transmitter. It is for this reason that the cavity must be built with the highest possible Q.

The cavity is somewhat shorter than optimum, but it is very effective in providing the desired selectivity. It is made from a 7" section of 4" brass pipe. The center conductor is a 6½" length of 1¼" copper pipe. The best source of supply for this stock is a local plumbing contractor. These lengths are too short for his needs and he will probably sell them to you as scrap.

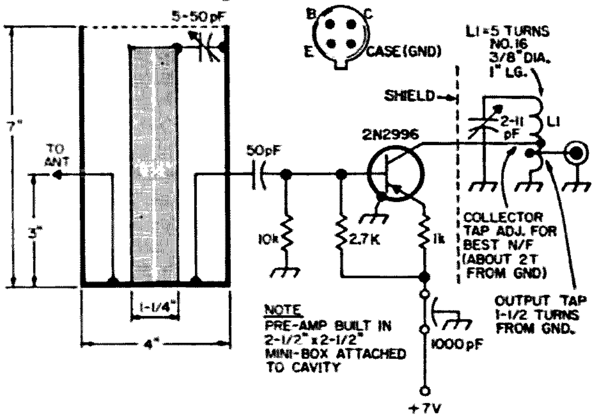
First make the end plates from sheet copper and cut a 1½" hole in the center of one to accept the center conductor. Solder this all around the pipe as this is a high current spot and must have very low resistance. Next bend two pieces of #12 bare copper wire for the pick up loops. Drill holes on each side ½" from the center conductor.

At this point you must decide whether to use the transistor pre-amp or not. The receiver will detect a .5 μV signal with 20 dB of quieting, and it will provide excellent results without the pre-amp. The pre-amp, however, should be used if you plan to use a very long coax line between the antenna and receiver.

Now punch two holes in the brass cylinder to accept two female type N chassis type coax connectors. If you want the pre-amp, one of the connectors can be a feed through insulator to feed the base of the transistor. Solder the wire loops to the coax connectors, and attach them to the cylinder. The wires will stick out the bottom.

Now slide the base plate over the pick up loops and solder the plate to the cylinder. Solder the loops to the bottom of the base plate. Install the tuning capacitor at the top and you're ready to go. After the cavity is tuned, you can solder the top plate to the cylinder.

The pre-amp showed the best NF with about 6 to 7 Vdc. To tune up the cavity and pre-amp, connect to your receiver and tune the cavity and pre-amp for maximum output with a weak signal. A noise generator will allow the optimum adjustment of the collector tap, but this is about two turns from the ground end.



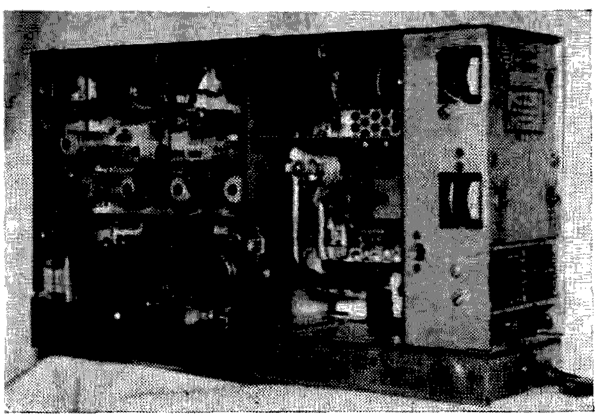
Simple coaxial cavity and transistor preamplifier. The emitter should be bypassed to ground with a 1000 pF capacitor.

are visible mounted on the base plate. Punch a hole in the base chassis and mount a 11 pin socket (PI) so that the receiver power plug can be connected. A small power supply, delivering 12.6 V ac and 150 V dc can be constructed to furnish power to the receiver as shown in **Fig. 2.** It is suggested that this be constructed on the receiver chassis base plate. By carefully orienting the transformers, the parts can be fitted. The voltages are now fed to P1 on the base. There are many variations of transformers but they must be small. Most any 110 V 40 watt isolation transformer will work. On the front of the base assembly between the four small holes that were used as the old receiver test points, mount two miniature pots, 10 kΩ for the squelch and 100 kΩ for the volume. Connect these to P1 as shown (**Fig. 3**). The receiver has a provision for a second crystal using one half of the 12AT7 as oscillator. This half of the tube is not needed, and for repeater service is wired to key the PTT line in the transmitter. Build the circuit as shown in **Fig. 3** using the unused half of the 12AT7. The frequency 2 lead to the power plug can now be used to connect the PTT line to the transmitter as shown. The frequency 2 lead is the middle lug on the three lug terminal strip next to the oscillator tube (lug 2 of TB 15). It can be seen that a small positive voltage on pin 5 of V-311 will cause tube V-314 to conduct. This current will hold the keying relay operated. A received signal causes pin 5 of V-311 to go negative and this cuts off V-314. This in turn will release the relay and ground will be applied through the now closed contacts of the relay. This ground will now key the transmitter. Audio from the receiver is fed through plug P1 to the FM modulator.

The receiver will require two crystals; one for the high frequency oscillator and the other is used as a transmitter frequency suck-out crystal to place a low impedance path to ground at the transmit frequency. This crystal connected in this manner prevents the receiver from being overloaded and thus desensitized by the strong transmitter carrier. To figure the high frequency crystal use the formula below.

$$\text{crystal frequency} = \frac{\text{operating frequency } -8.7}{12}$$

for a receive frequency of 143.46 this would be 11.23 MHz.



The transmitter is shown with one side removed. The 5894 final amplifier can be seen with its quarter wave tuned lines. The oscillator and multiplier stages are in the rear compartment at the left.

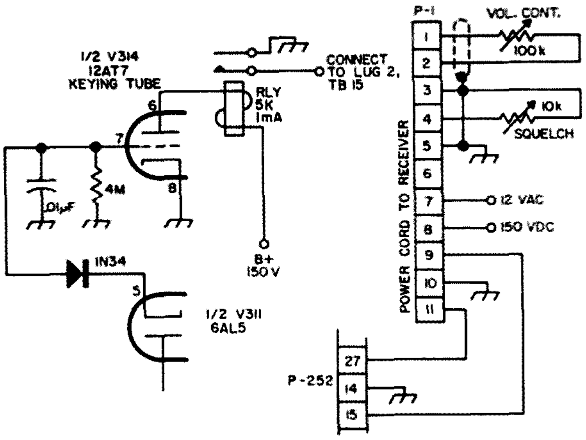


Fig. 3. Transmitter keying tube and control circuits.

The transmit frequency eliminator crystal is shown in **Fig. 4.** This crystal was ordered from International Crystal Company, Oklahoma City, Oklahoma. They are familiar with this. When ordering this crystal give the following information: *Example:* 143.95 MHz third overtone crystal–This crystal will be connected from grid to ground of the 6AK5 rf amplifier in a GE 4ER25D receiver to eliminate a strong transmitter carried on 143.95 MHz. This receiver will be tuned to 143.46 MHz and a high Q coax cavity will be inserted between the antenna and receiver. This crystal is to prevent the receiver from being desensitized by the 143.95 MHz transmitter. This crystal should be ordered with wire leads. The cost $6.90.

Connect this crystal in the antenna coil can across the rf amp grid coil as shown in **Fig. 4.** On using this crystal in this manner, it can be seen that any power present here will destroy the crystal so be careful. This crystal is not guaranteed in this application but if installed and operated as shown, no problems should be encountered.

Install a phono type plug on the antenna coax that goes to A2 of P-252. This will plug into the antenna jack on the receiver. The fuse in the receiver can be mounted in the base at any convenient spot. The 0.1 µF capacitor and 4 MΩ resistor in **Fig. 3** act to

hold the transmitter operated for about 1 second after the 143.46 MHz signal is gone. This was done to prevent the rapid flutter so common in two meter mobile communications from causing the repeater to chop.

Turn power on to unit and check for proper voltages. A signal generator and a vom of at least 20,000 ohms per volt is needed for alignment. Connect signal generator to P-1901 on back of cabinet and tune generator of operating frequency of receiver.

Use a 20,000 ohm/volt meter with one lead to ground and connect the other as directed:

Connect to	Adjust	Required Reading
OSC	Top OSC Coil Maximum	1.3 V
MULT	Mult Can Top and Bottom	Maximum

Feed 143.46 MHz signal at the antenna jack —increase level till LIM 1 shows indication—

LIM 1—Mult 2 both capacitors
RF amp both capacitors
Ant top and bottom

Repeat all adjustments (except oscillator coil) until required sensitivity is obtained. (Requirements .5 μV for 20 dB of quieting). With a known accurate signal at 143.46 MHz adjust the oscillator crystal frequency adjust capacitor for zero reading when meter is connected to the discriminator. This completes the receiver alignment.

Final adjustments

Remove the back cover of the FRC-27 and make the following connection to the terminal strips:

TB-1901	Connect terms	6-7
	Connect terms	8-10
	Remove wire between	2-3
TB-1902	Connect terms	2-3
	Control Unit C 844U	
TB-701	Connect terms	2-3
	Remove wire between	1-2

This completes the conversion and it is only necessary to set the levels of transmission. There will be three controls in the audio line: receiver volume, L pad in control unit and deviation control in the transmitter. As a guide to start with, keep the receiver level low as this will lessen the noise level on the transmitter audio. The L pad is a very effective impedance matching device and when used with the deviation control, it should be possible to get full deviation on most all levels of input signal. The squelch control is adjusted to the point where noise does not trip the repeater.

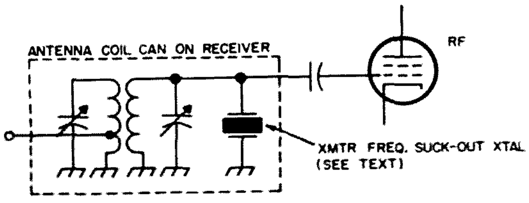
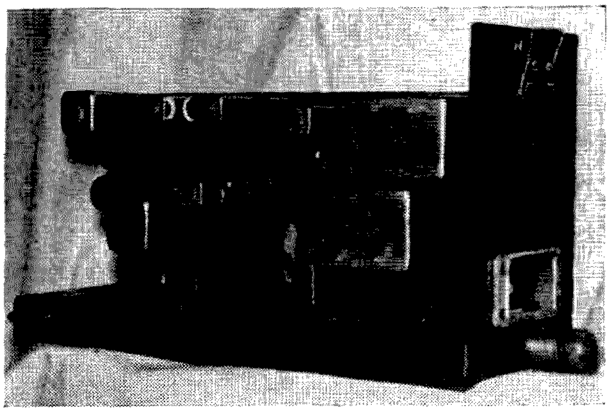


Fig. 4. Connection of the transmit suck-out crystal.



The modified GE receiver is mounted on its side so it will fit on the existing chassis. Plug P252 is shown on the back and the filament and plate transformers are visible mounted on the base plate.

The antennas used here are stacked horizontally polarized big wheels separated by about twenty feet between transmit and receive.

The work in building this repeater was not done overnight and many hours of cut and try and looking into problems in other repeaters were necessary. We feel this has paid off, however, in the quality of retransmission and dependability we have obtained. The repeater at Houston is located on the KPRC-TV tower (1400 ft.) and excellent mobile coverage is obtained up to 60 miles radius. Base stations work out about 150 miles and farther in some directions. I am located 220 miles from Houston and can use the repeater most of the time.

I have worked San Antonio through the repeater on many occasions which is in excess of 400 miles from Tyler.

The holdover of the receiver gives me a constant check on the band conditions as I can listen for the repeater to drop out.

This repeater project was built by AFCS Air Force MARS people to operate on two meter MARS frequencies, and plans call for 23 of these repeaters to cover ten states in the Central United States. At this time four units are operational with five more near completion. These units were built according to these instructions, and all have worked properly.

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Complete Overload Protection

Here's one of the more original schemes we've seen recently.

Here is a circuit that offers much for all builders and nuts that dream up rigs that are as well engineered as the state of the art. This circuit offers complete overload protection for the whole rig (including output, temperature, and VSWR as well as the more common current protection) with one, or at the most two, relays. As many sensors as wanted may be included.

The basic circuit (see **Fig. 1**) uses a silicon-controlled rectifier, or SCR, that semiconductor equivalent of the thyratron. Whenever the gate current exceeds the threshold the SCR saturates and remains conducting until the anode circuit is opened. When the SCR fires, K1 is actuated and can open the PA cathode circuit, operate a heavier relay, light an indicator lamp, or any other desired function.

With this basic actuator circuit you can use any or all of several sensors. The only requirement is that the sensor develop a few volts positive. With the unmarked junkbox SCR I use 0.2 MA of gate current, 2 volts across the 1 k gate resistor causes the SCR to fire with 10 volts on the anode (stolen from the filament transformer).

For plate current protection a 5 ohm resistor (of suitable wattage) is put between ground and the PA tube cathode (or in the B-return of the PS). For 1 ampere of plate current 5 volts are developed. (See **Fig. 2A.**) Using about 5 k for the adjusting resistor "R" you can set the voltage to the gate for any value at the predetermined plate current (for me it trips at 800 MA).

Screen protection is provided by monitoring the current drawn by the shunt screen regulator, a string of 10 watt zener diodes in my rig. (See **Fig. 2B.**) As screen current increases the regulator current decreases equally. By placing a small resistor in the ground return of the regulator you can pick off a couple of volts. Here a transistor (PNP) is used to get a phase reversal, rising positive voltage for decreasing regulator current. A blocking diode is

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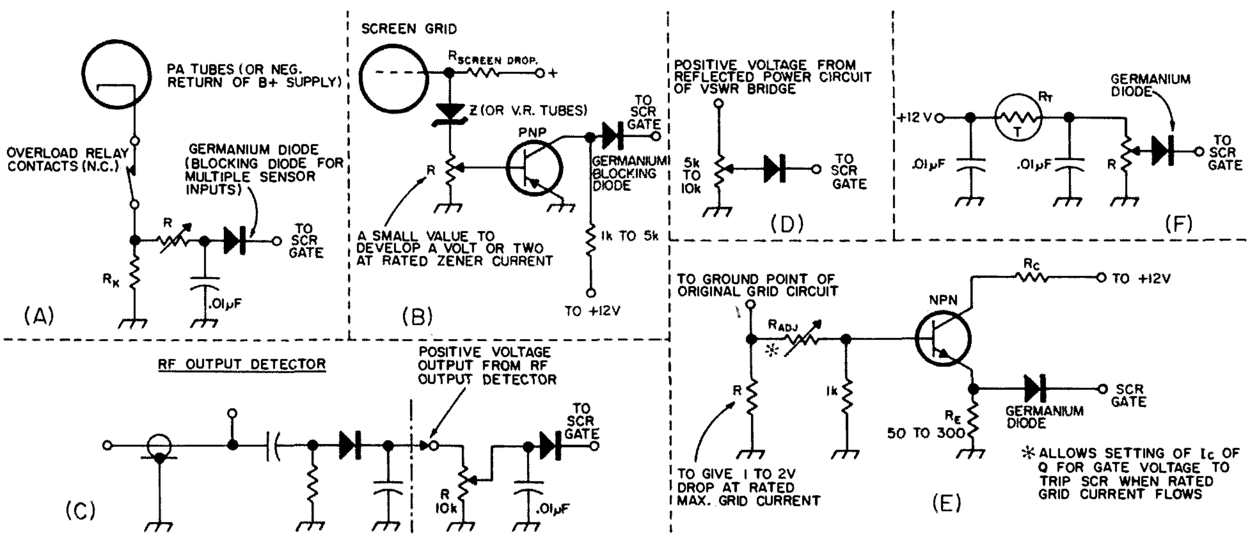

Fig. 2. Sensors for the overload circuit in Fig. 1. A. Protection against too much plate current. B. Screen current protection. C. Excessive output protection (You don't want to exceed the legal limit, do you?) D. High VSWR protection. E. Protection against loss of grid drive. F. Excessive temperature protection. See text for more complete explanation of these circuits.

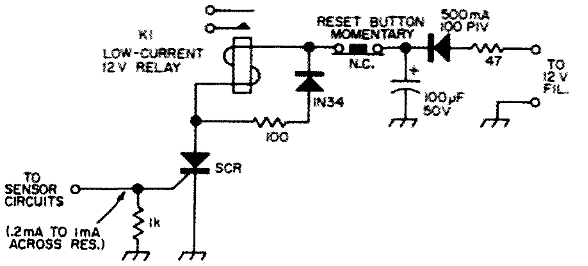

Fig. 1. Basic circuit for overload protection. This SCR and relay will turn off your transmitter (or ring a bell) when almost anything goes wrong with your station. See Fig. 2 for examples of sensors.

used on this (as well as on all the other sensors to prevent interaction between the inputs). Adding the few ohms of resistance in the screen regulator won't affect the regulation by more than a percent or so.

By using an output rf voltmeter diode circuit you can set a safe maximum power output level and protect the tubes from excessive power (or keep from running illegal power!) See **Fig. 2C.**

Another outstanding protective circuit can use the reflected power output from your VSWR bridge (positive diode polarity) to remove power in case of a damaging high VSWR. This could save a PA stage if an antenna or coax fails (or in my case if I patch the wrong antenna into the rig). See **Fig. 2D.**

Grid current can be likewise monitored, again using a transistor (NPN) to get the proper sensor output signal. See **Fig. 2E.**

Another important function can be monitored by using a thermistor of the proper temperature/resistance characteristic in a voltage divider circuit. Placing the thermistor close to the tubes or in the exhaust air stream will let the monitor keep watch on those precious bottles and shut things down before the plates melt or the seals rupture. See **Fig. 2F.**

You can probably dream up several other circuits for different applications. Using a microphone and audio amplifier with a rectified output the telephone bell or the XYL's last chow call will terminate transmission effectively.

One important point: These circuits must be carefully bypassed and shielded in most cases to prevent rf pickup and rectification by the sensors and/or the SCR.

Try this one relay, multi-function overload protector and I think you'll have as much fun and get as much peace of mind as I have. It works, smoothly and positively, is cheap and small. Its applications are limited only by your imagination.

. . . W4ZUS

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Vashon, Wash. 98070

Heathkit HM-15 SWR Meter

If you have a ten dollar imported SWR meter and like it, as I do, you may wonder if a few bucks extra for the Heath HM-15 can be justified, as I did, but you may not have an opportunity to try them side by side, as I have. (They won't measure prepositional phases, so they won't really work in parallel.) Some of the Heath meter advantages that impressed me are reflected below.

Terminating resistors are supplied for both 72 and 52 ohm operation—a worthwhile provision. To change from one to the other requires removal of the chassis from the cabinet and application of a soldering iron, but this takes only a couple of minutes, and it isn't something you would do very often. The change could be made by switching, but the instant convenience gained would be too expensive in terms of added capacitance, asymmetry and associated problems which would have to be solved. It's nice to have the two impedance ranges simply and cheaply.

Some HM-15 Specifications

Operation: Indicate percent of forward and reflected power, and voltage standing wave ratio.
Power Handling Capability: One kilowatt of rf.
Impedance: 50 or 75 ohms.
Frequency Coverage: 160 through 6 meters.
Meter: 100 microamperes.
Dimensions: 9¼ x 3⅝ x 2⅝ inches.

The cabinet is attractive, stiff, and designed to sit prettily atop your transceiver—rubber feet on the bottom and coax connectors in the back. For mobile operation the HM-15 takes little room under the dash, and if it is mounted with screws through the cabinet top you can remove the chassis in about thirty seconds by unscrewing the two self-tappers on each end.

Besides being fun, kit-building is a relatively painless educational experience, and this is one kit you really can assemble in an evening. In fact, you can put it together, squirt your transmitter through it, check the SWR, test the surplus lengths of coax on hand, confirm the non-reactive behavior of your dummy load, roundtable for an hour (while you watch the HM-15 for evidence of carrier non-suppression) and still beat the kids to bed.

The manual is a useful bonus. A thoughtful effort has been made to explain clearly the theory and operation of SWR meters. With two charts and a couple of pages of text the manual makes the most of the benefits offered by the put-it-together-yourself approach. The limitations as well as the capabilities of SWR meters are noted, and the comments may leave you with an irresistible urge to dig out 73 articles on the taming and feeding of antennas. All to the good.

At $14.95 the HM-15 is one of life's inexpensive necessities.

. . . W7IDF

1966 Eico Catalog

Eico's new 48 page catalog illustrates and describes their complete line of more than 250 products, including amateur radio equipment, test instruments and stereo hi-fi components. Copies of this new catalog are available free from Eico Electronic Instrument Company, 131-01 39th Avenue, Flushing, New York.

Creative Electronics Fabrication

If you like to make professional-looking electronic equipment, this new book by Owen Patrick should be of interest to you. The title is *Creative Electronics Fabrication* and it's published by Holt, Rinehart and Winston. Virtually all electronic construction techniques that the amateur could need are covered. You can order a copy through your local bookshop.

Radio Products Sales' Catalog

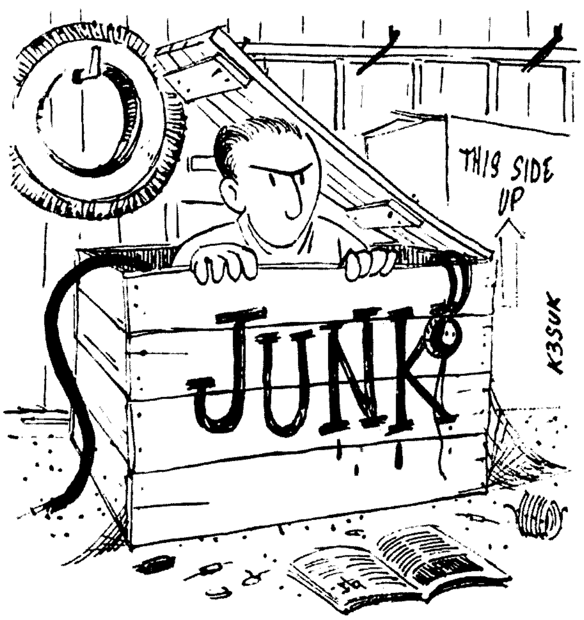
Radio Products Sales Inc., has just announced a new 300-page catalog of electronics parts and equipment. This new catalog covers a wide variety of electronic components from 86 leading manufacturers and is of considerable use to amateurs and electronics engineers. It is thoroughly and accurately indexed for easy reference, profusely illustrated and where applicable, contains industrial net prices. These new catalogs may be obtained by writing to Radio Products Sales Inc., 1501 South Hill Street, Los Angeles, California 90015.

Electronic Design Charts

Most hams seem to like to avoid using mathematical formulas and equations as much as possible, but if they do much experimenting and designing, they have to figure out many things. Graphs and nomographs are one way to find specific values for components and other electronics quantities without much math. Norman Crowhurst's *Electronic Design Charts* contains 59 useful charts that will help you design many circuits and networks. It's bound in a very convenient loose leaf fashion with complete and clear explanations and examples for each chart. Cost is $5.95 and you can buy a copy from your distributor or Gernsback Library, 154 West 14th Street, New York, N.Y. 10011.

1967 Lafayette Catalog

Lafayette's new catalog is now available at no charge. You're already familiar with them and know that it's something you'll have to have, so why not send for your copy now? Lafayette, P.O. Box 10, Dept. PR73, Syosset, N.Y. 11791.



Merritt Franken WA6JNI
3714 Mound View Ave.
Studio City, California

A Pox on Your Junk Box

Been a ham now ten or twelve years or so, give or take a bit. It all happened when I had the dubious fortune to meet Wayne Green in the living, quivering flesh. Exposed to his torrent of talk it wasn't long before I went the way of so many others and there was the code oscilator and the hand key and the books and the butterflies in the stomach at the thought of taking the test. So here I am, a decade or so later, duly licensed, poorer by several thousands of dollars, richer by a number of hammet friends and sizzling with a long-smoldering peeve.

The peeve? Easy. It's this junk box jazz I keep reading about.

Almost the first thing I noticed when I started reading ham magazines is that they all seem to be liberal in referring me—or any other reader—to the junk box. Building an antenna, That little plastic dimity you need is bound to be in your junk box. Whacking away at a speech compressor? That capacitor you need to make your next contact think your audio sounds like the squeaks of a lovesick porpoise is in your junk box. Right on top if you'll look carefully. Etc. etc. etc.

Oh, I have a junk box, all right. Matter of fact my wife (she's a ham too and truth be known beat me to it in getting the general ticket) says I have junk boxes all over the place. In several drawers in the shack desk. A clutter in the workshop. Boxes of moldy goodies in the garage. I often wonder how come and why the XYL became a ham but it seems damn sure to me that if she hadn't there'd have been a divorce in these parts for sure.

So the other day I got to thinking about the junk box. What started me was that several articles I'd just read, each of which said the whole project would cost about 38¢ and even less if I took recourse to you-know-what, had led me down the primrose path again. As a result, I now have, in various stages of non-completion, a variety of junk box projects, including a 40 meter QRP cw rig, a transistorized keyer and a couple of others I'm too irritated to mention. What happened in each instance is that my capacious junk box wasn't capacious or junky enough and by the time I finished pricing out parts I needed I could have bought my wife a dress (as she often reminds me) or paid for a week's vacation or maybe gone to a local ham emporium and bought the thing to begin with.

That's when I came to my Big Decision. I was going to breadboard The Project, right out of my own junk box. Just start out easy and see where it led. First thing I needed was a breadboard. No problem. We got a beaut from some travelling friends a year or so ago. They sent it to us from Africa and the fact that it was ebony didn't make any particular difference to me. Next, start mounting components. That beautiful butterfly variable would look real nice in the lower right hand corner. I got that little goody when I made an ill-advised trip to a surplus joint and if you remember, the poet said, "A butterfly capacitor is a thing of beauty forever"—or words to that

effect.

Next came a series of resistors, or vice versa. Got those as a going away gift from a friend when we moved to California from New York. In the hundreds of times I've needed resistors since then I've never been able to find anything even close to the sought after value in the whole batch, so might just as well get rid of them.

All sorts of goodies followed in quick succession. Some diodes I got because I thought I could use the little plastic boxes they came in; couple of transformers, one of which was painted forest green to serve a better purpose as a door stop; tube sockets; my original hand key; the first 807 to go flat in my fondly-remembered Harvey-Well TBS50D. There was still some room on the ebony breadboard so I covered some of the space with some of my old K2KEH (my New York call) QSL's I'd saved for sentimental reasons and in the remaining space I mounted some SO 239's because they looked so pretty.

That's when the XYL marched in. Neither of us said a word but I started hearing a sizzling sound and that puzzled me because I hadn't turned on the B plus. The sizzle got louder, like tube noise only more so. It stopped only when she spoke:

"What's that?" said she.

"I'm not sure," said I, "but I think it may work out to be a miniaturized digital computer. Maybe in color."

"Is that my good bread board?" said she.

"It is," said I.

"You mean it was," said she.

"Yes," said I, and now I was getting that little scary feeling that says to all married men, "Look out, chum, there's domestic QRM upcoming."

"Isn't silver an excellent conductor?" said she—a little out of sequence I thought.

"Yes."

"Then why don't you take the good sterling," she said sweetly, "and hook up all the components with it. And you can use the good china for insulators, while you're at it."

And she walked out of the room. The sizzle was S9 plus.

She came back home from mother's a few days later. She had only one suggestion for me. "If you're going to breadboard something from scratch," she said, "why don't you really start from scratch? Like go out to begin with and get me a brand new bread board."

So I went out and bought an axe and now I'm looking for an ebony tree. Africa, anyone?

A pox on your junk box.

. . . WA6JNI

Vester Scott KØEFC
2229a Marconi Street
St. Louis, Mo. 63110

Electronic Drafting for the Ham Writer

Even if you aren't a ham writer you'll find this article interesting.

It is an indisputable fact that successful communication, in even the broadest sense, is dependent upon three vital factors which are coincidentally related to amateur radio.

The first of these factors is the transmitter, or a person who speaks, writes, or in some way seeks to communicate. Here we may make an analogy to 73's authors, who are among the finest in amateur radio writing circles.

The second requirement is the receiver, or listener, or in the context of this article, the reader. Most of us read an amateur radio publication for the express purpose of educating ourselves in one way or another. No problem here, unless. . . .

Scottie is 73's main draftsman. He's the one who gets the credit for most of the excellent drawings we publish. Long time readers of 73 will notice the great improvement in layout, consistency, attractiveness, completeness and accuracy in Scottie's work over earlier drawings. Aside from his work for 73, Scottie is a design draftsman for the Security Fire Door Company of St. Louis.

You guessed it! Unless we use the wrong *third* factor, the *code*. It is essential that this code be a language which is mutually understood.

Lest I be set upon by a battalion of irate 73 authors and hanged from the corner of my drawing board, let me hasten to explain that the primary purpose of this article is to explain the standard drafting symbols and methods used in 73 and many other electronics magazines such as 73. A welcome by-product would be the successful stimulation of any potentially good but currently latent writers who hesitate to submit articles because they fear their drafting ability is not up to par.

Many of us, I am sure, read 73 and build according to the schematics without giving much thought to what goes on behind the scenes. We probably concern ourselves but little about the fact that the author's original sketches might have looked somewhat different from the drawings which appeared in the magazine. This is common, the reason being that the staff artist is governed by strict policies of the magazine concerning space and shape requirements, and standardization of drafting procedures.

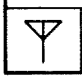
So, now that we agree that our drawings are going to appear in 73 in accordance with a standard format, come TVI or high water, why make the artist work so hard for his money?

Included with this article is a chart which describes most of the symbols and abbrevia-

(Text continued on page 76.)

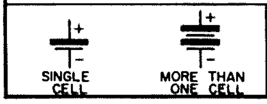
E L E C T R O N I C   S Y M B O L S

ANTENNA



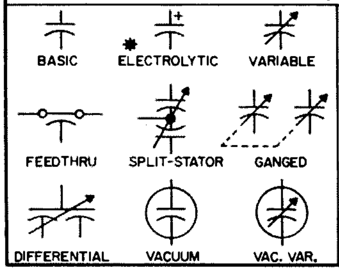
NORMALLY USED IN BLOCK DIAGRAMS, BUT MAY BE USED IN ANY SCHEMATIC WHERE ANTENNA IS CONNECTED DIRECTLY TO CIRCUIT WITHOUT BENEFIT OF RF CONNECTOR

BATTERY



DO NOT FORGET TO INDICATE VOLTAGE AND POLARITY

CAPACITORS



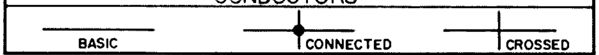
NOTE THAT CURVED PORTION OF SYMBOL ALWAYS DESIGNATES OUTSIDE FOIL OF FIXED CAPACITORS (EXCEPT ELECTROLYTICS, WHERE IT INDICATES THE NEGATIVE TERMINAL)

THE CURVED PORTION IN THE CASE OF A VARIABLE WILL INDICATE THE MOVABLE PART

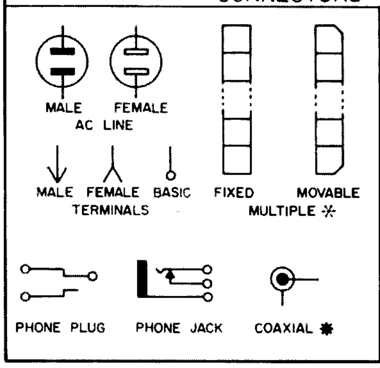
✱ INDICATE POLARITY, AND VALUE IN µF

WHEN OTHER THAN ELECTROLYTIC, VALUES ARE ASSUMED TO BE pF WHEN 1 OR GREATER, AND µF WHEN LESS THAN 1

CONDUCTORS



CONNECTORS

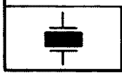


SHOULD NONE OF THE SYMBOLS DESCRIBED HERE SEEM TO MATCH YOUR SITUATION, DESCRIBE THE CONNECTOR AND/OR LIST THE MANUFACTURER'S PART NUMBER

✱ FOR ANY COAXIAL-TYPE CONNECTOR, SUCH AS RF, MICROPHONE, PHONO, ETC.

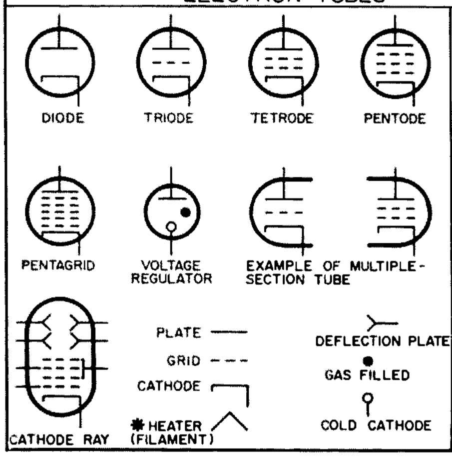
✲ NUMBER THE BLOCKS TO CORRESPOND TO TERMINAL MARKINGS, WHEN APPROPRIATE

CRYSTAL



ALWAYS INDICATE CRYSTAL FREQUENCY (IN kHz, MHz, ETC.)

ELECTRON TUBES

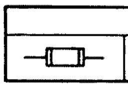


ALWAYS LABEL ELEMENTS WITH TUBE PIN NUMBERS

REFER TO TUBE MANUAL FOR DATA ON INDIVIDUAL TUBE TYPES

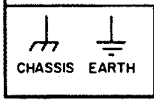
✱ FILAMENTS OR HEATERS (WITH THE EXCEPTION OF DIRECTLY-HEATED CATHODES) SHOULD BE SHOWN EXTERNAL TO TUBE CIRCLE, AND PREFERABLY IN THE POWER SUPPLY

FUSE



INDICATE CURRENT, VOLTAGE RATINGS, AND SLO-BLO, ETC., AS APPROPRIATE

GROUND CONNECTIONS



CHASSIS GROUND SYMBOL IS NORMALLY THE ONLY TYPE USED IN SCHEMATICS

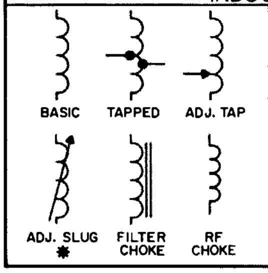
EACH GROUNDED CIRCUIT COMPONENT WILL BE SHOWN CONNECTED TO AN *INDIVIDUAL* CHASSIS GROUND, UNLESS A COMMON GROUND BUS IS ESSENTIAL TO PROPER CIRCUIT OPERATION

HEADSET

NORMALLY USED IN BLOCK DIAGRAMS, BUT MAY BE USED IN ANY SCHEMATIC WHERE CONNECTED DIRECTLY INTO CIRCUIT WITHOUT PHONE PLUG

INDICATE IMPEDANCE IF VALUE IS CRITICAL

INDUCTORS



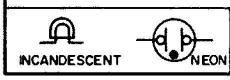
INCLUDE ALL NECESSARY DATA INCLUDING ANY OF FOLLOWING INFORMATION WHICH IS APPLICABLE:
- WIRE SIZE & TYPE
- COIL OR FORM O.D. OR I.D.
- NUMBER OF TURNS AND/OR LENGTH
- MANUFACTURERS PART NUMBER
- TAP POSITION ABOVE COLD END

✱ FERRITE CORE WILL BE ASSUMED UNLESS BRASS IS SPECIFIED. INDICATE TYPE OF FERRITE, IF CRITICAL

KEYS

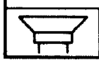
✱ BE SURE TO DESIGNATE "DIT" & "DAH" CONTACTS

LAMPS



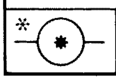
INDICATE MANUFACTURER'S PART NUMBER AND/OR VOLTAGE & CURRENT RATING

LOUDSPEAKER



INDICATE VOICE COIL IMPEDANCE & POWER RATING, ETC., WHEN CRITICAL

METERS



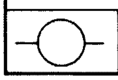
✱ INDICATE TYPE OF METER HERE (µA, mA, V, ETC.)
✲ INDICATE SCALE RANGE HERE (0-1, 0-50, ETC.)
DON'T FORGET TO INDICATE PROPER POLARITY

MICROPHONE

NORMALLY USED IN BLOCK DIAGRAMS BUT MAY BE USED IN SCHEMATIC WHEN WIRED DIRECTLY INTO CIRCUIT WITHOUT CONNECTOR

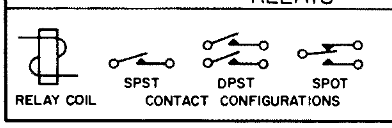
INDICATE TYPE (CARBON, XTAL, ETC.)

MOTOR



LABEL AS MOTOR, FAN MOTOR, ETC.
INDICATE OPERATING VOLTAGE & CURRENT AND/OR MANUFACTURER'S PART NUMBER

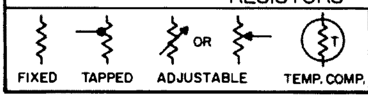
RELAYS



SPECIFY COIL VOLTAGE, RESISTANCE, ETC., AND/OR MANUFACTURER'S PART NUMBER

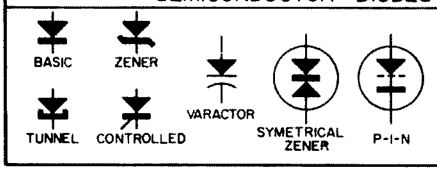
CONTACT CONFIGURATIONS SHOWN ARE BASIC AND MAY BE EXPANDED

RESISTORS



INDICATE VALUE, IN OHMS (Ω), KILOHMS (k), OR MEGOHMS (M), AND/OR MANUFACTURER'S PART NUMBER.
1/2W 10% IS ASSUMED UNLESS OTHERWISE NOTED

SEMICONDUCTOR DIODES

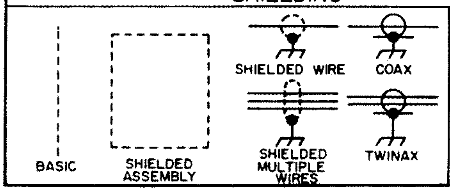


INDICATE MANUFACTURER'S PART NUMBER AND APPROPRIATE RATINGS

REFER TO MANUALS FOR SYMBOLS NOT SHOWN

ELECTRONIC SYMBOLS

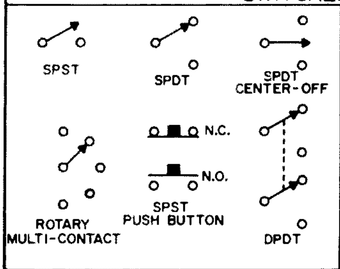
SHIELDING



SHIELDS ARE ASSUMED TO BE GROUNDED UNLESS OTHERWISE NOTED

INDICATE IF SHIELD ON CONDUCTOR IS TO BE GROUNDED AT ONE END ONLY, & SPECIFY WHICH END

SWITCHES



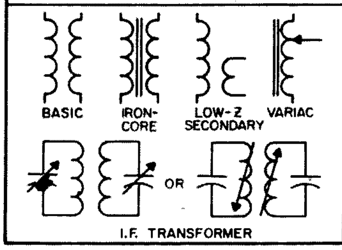
ONLY BASIC CONFIGURATIONS ARE SHOWN. COMBINE OR EXPAND AS NECESSARY TO SUIT

SELF-HOLDING SWITCH OPERATION IS ASSUMED UNLESS SPRING-RETURN IS SPECIFIED

NON-SHORTING TYPE IS ASSUMED UNLESS SHORTING TYPE IS SPECIFIED

SWITCH SECTIONS WHICH ARE SIMULTANEOUSLY OPERATED OR GANGED SHOULD BE JOINED WITH A DOTTED LINE

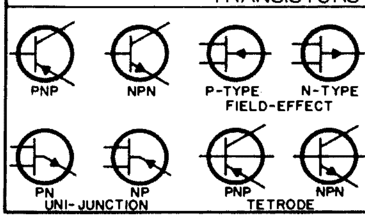
TRANSFORMERS



SHOW (4) LOOPS EACH WINDING EXCEPT (6) LOOPS ON HIGH-VOLTAGE SECONDARIES AND (2) ON FILAMENT WINDINGS AND NON-RESONANT LOW-Z RF COUPLING LINKS

TRANSFORMER DESCRIPTION SHOULD INCLUDE MANUFACTURER'S PART NUMBER AND RATINGS, OR CONSTRUCTION DATA

TRANSISTORS



SPECIFY MANUFACTURER'S PART NUMBER OR RATINGS

REFER TO TRANSISTOR MANUALS FOR TYPES NOT SHOWN HERE.

ELECTRONIC ABBREVIATIONS

(AS USED ON DRAWINGS AND SCHEMATICS)

NOMENCLATURE	ABBREVIATION(S)
ALTERNATING CURRENT	AC
AMPERE	A
AMPLIFIER	AMP
AMPLITUDE MODULATION	AM
ANTENNA	ANT
AUDIO FREQUENCY	AF
AUTOMATIC FREQUENCY CONTROL	AFC
AUTOMATIC GAIN CONTROL	AGC
AUTOMATIC VOLUME CONTROL	AVC
BATTERY	B
BEAT FREQUENCY OSCILLATOR	BFO
BROADCAST	BC
CAPACITANCE, CAPACITOR	C
CONTINUOUS WAVE	CW
CRYSTAL	X, XTAL
CURRENT	I
DECIBEL	dB
DIODE, SEMICONDUCTOR (ALL TYPES)	D
DIRECT CURRENT	DC
DOUBLE COTTON COVERED	D.C.C.
DOUBLE POLE DOUBLE THROW	DPDT
DOUBLE POLE SINGLE THROW	DPST
DOUBLE SILK COVERED	D.S.C.
ELECTRON TUBE (ALL TYPES)	V
ENAMEL COVERED	ENAM
FILAMENT	FIL
FREQUENCY	FREQ, f
FREQUENCY MODULATION	FM
FUSE	F
GROUND	GND
HENRY	H
HERTZ (CYCLES PER SECOND)	Hz
IMPEDANCE	Z
INDUCTANCE, INDUCTOR	L
INSIDE DIAMETER	I.D.
INTERMEDIATE FREQUENCY	I.F.
JACK	J
KILOHERTZ (KILOCYCLES PER SECOND)	kHz
KILOHM	k, kΩ
KILOVOLT	kV
KILOWATT	kW
LAMP	I
LOUDSPEAKER	SPKR
MEGAHERTZ (MEGACYCLES PER SECOND)	MHz
MEGOHM	M, MΩ
METER	M
MICROAMPERE	μA
MICROFARAD	μF
MICROHENRY	μH
MICROPHONE	MIC
MICROVOLT	μV
MICROWATT	μW
MILLIAMPERE	mA
MILLIHENRY	mH
MILLIVOLT	mV
MILLIWATT	mW
NEGATIVE (POLARITY)	−, NEG
NORMALLY CLOSED	NC
NORMALLY OPEN	NO
OHM	Ω
OSCILLATOR	OSC
OUTSIDE DIAMETER	O.D.
PICOFARAD	pF
PLUG	P
POSITIVE (POLARITY)	+, POS
POWER AMPLIFIER	PA
PRIMARY	PRI
PUSHBUTTON	PB
RADIO FREQUENCY	RF
RADIO FREQUENCY CHOKE	RFC
RECEIVE	REC
RECEIVER	RCVR
RELAY	K
RESISTANCE, RESISTOR (ALL TYPES)	R
ROOT MEAN SQUARE	RMS
SECONDARY	SEC
SHORTWAVE	SW
SINGLE COTTON COVERED	S.C.C.
SINGLE POLE DOUBLE THROW	SPDT
SINGLE POLE SINGLE THROW	SPST
SINGLE SILK COVERED	S.S.C.
SWITCH	S
TIME	t
TRANSFORMER	XFMR, T
TRANSISTOR (ALL TYPES)	Q
TRANSMIT	XMIT
TRANSMITTER	XMTR
ULTRA HIGH FREQUENCY	UHF
VACUUM TUBE VOLTMETER	VTVM
VERY HIGH FREQUENCY	VHF
VOLT OHM METER	VOM
VOLT, VOLTS	V
VOLTAGE	E
WATT	W
WAVELENGTH	λ

(Continued from page 72)

tions which have been found acceptable to the editor of 73. Relative information has been included in the chart, rather than in the text, for convenience. Should none of this information seem to suit your situation, merely make your description as complete as possible. Always bear in mind that you are seeking to communicate with the artist, and ultimately, with the reader.

Hopefully, we are still in agreement at this point. Now, let's draw all schematics with input at left and output at right. Don't hesitate to direct an explanatory note or two to the artist if you think a particular item might not be clear to him. This is especially important in the case of pictorials, where a drawing might otherwise appear in print embarrassingly unlike a photograph of the same object. Use templates if you like, but free-hand is just as good as long as it is legible. Try to include most of the information on the schematics, thereby keeping the parts list to a minimum. When finished with your drawings, inspect for errors or omissions.

If you are an old hand at writing in the electronics field, perhaps you are one of the many who already adhere fastidiously to the use of standard symbols and layouts. If not, won't you please bend a little? It *could* prevent the artist from accidentally blowing an otherwise excellent article.

Those of you who have originated interesting and useful circuits, and have never submitted them for publication, are cheating amateur radio out of the benefit of your knowledge, and yourself out of a couple of bucks. I can't tell you how to write the article because that is way out of my line. I can tell you, however, that a pencil, paper, and an unyielding determination to use standard symbols, abbreviations, and format, will satisfy the drafting requirement. Don't forget to retain a copy of everything, for reference, in case the editor wants to contact you about a point or two.

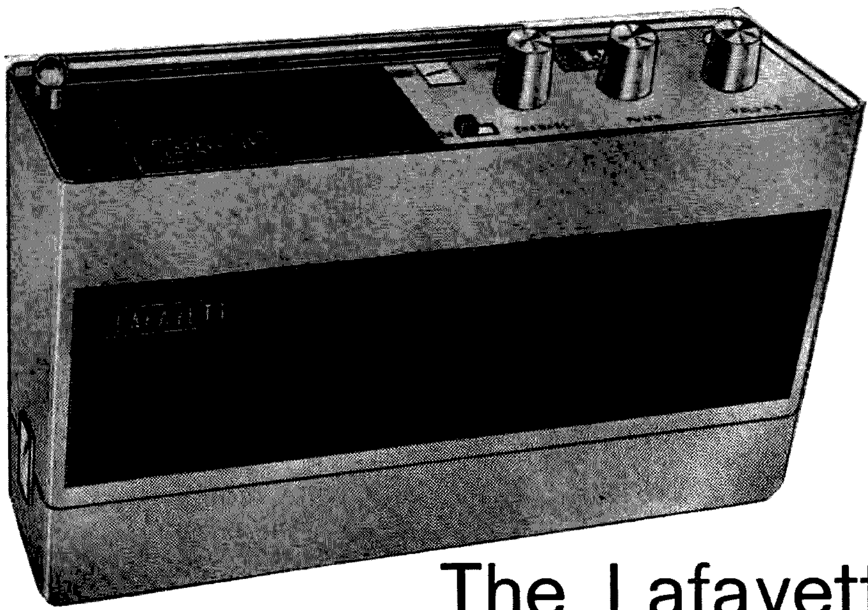
In conclusion, may I say that the objectives of this article are intended to be neither in defiance of nor in compliance with the policies of publications other than 73 magazine. The symbols and abbreviations which appear in the chart have been proven to be simple to execute, and adequately descriptive.

. . . KØEFC

References

A.R.R.L. "The Radio Amateur's Handbook," 1966 Edition, page 516

Howard W. Sams "Handbook of Electronic Tables & Formulas," 1962, pp. 82-94



The Lafayette HA-650 Six Meter Transceiver

A battery-operated portable or fixed transceiver

Most hams would like to have a completely portable transceiver. Some want to be prepared for emergencies. Some like to mountaintop. Some just like the idea of having a completely independent rig to carry around for special events or picnics. The Lafayette HA-650 is perfect for these uses. It is small, light, has a sensitive receiver, and adequate power for most of these uses. Let's take a quick look at what's in it:

The receiver uses five modern silicon transistors in a single conversion superheterodyne. The rf amplifier is protected by a diode against nearby transmitters, and the oscillator is zener diode stabilized. Two *if* stages at 1650 kHz furnish plenty of amplification. A noise limiter is wired in the circuit and the AGC has a squelch-like action: when no signals are being received, there's very little output from the speaker until a signal is received. There's plenty of audio for use except in very noisy locations when earphones would probably be worthwhile. A spot switch lets you find your operating frequency.

The transmitter uses 8 MHz crystals and sockets and a switch are provided for six crystals. Five silicon transistors are used in the transmitter and the circuit has plenty of filtering and selective circuits to prevent TVI. Both the driver and final are modulated for full modulation. There were many excellent comments on the audio. It has a very clean, communications-shaped quality and gets through interference very well.

The HA-650 operates from 12 volts or so. The package includes space for eight flashlight batteries, which seem to last quite a while, or you can install the rig in your car (positive or negative ground) using the mobile mount, power cord and instructions provided. You can also buy an AC adapter from Lafayette.

A whip antenna is built into the transceiver, and it is convenient to use for walking-portable use with the nice leather carrying case that comes with the rig. As this area is horizontally polarized, results with the whip weren't particularly dramatic, but stations 40 or 50 miles away were worked from a good location. Using the HA-650 with a beam or dipole made from a couple of Lafayette 58 inch telescoping whips is another story. We worked a number of stations 150 miles away from Pack Monadnock. Reports were S9 and better and everyone commented on the excellent modulation. The receiver stands up well to strong stations unless they are very close, when some cross-modulation becomes evident. It's not too serious though.

The instruction book is satisfactory in comparison with many other equipment manuals. It answers most of the questions you're liable to have about installing or using the rig, and also gives alignment instructions and a large schematic. Someone who isn't very familiar with semiconductors isn't going to enjoy servicing the transceiver, but otherwise it shouldn't be too bad—if service is ever needed, since everything seems to be well made and the parts

Lafayette HA-650 Specifications

Receiver
Sensitivity: better than 1 uV for 10 dB S/N ratio
Selectivity: 6 dB down at =3 kHz, 40 dB at =8 kHz
Image rejection: 55 dB
Frequency range: 50-52 MHz
Current drain: 80 mA

Transmitter
Input to final: 2½ watts
Modulation: Class B, 100% capability
Current drain: 400 mA maximum
T-R switching: relay type
Antenna output impedance: 50 ohms nominal

Miscellaneous
Power supply: 12 to 16 V dc
Dimensions: 9½ W x 5½ H x 2¼ D.
Weight: 9 pounds with battery
Price: $119.95

are conservatively rated. The driver and final transistors are made by Motorola, and the others would be easy to replace with standard American replacements if you had trouble finding the Japanese ones.

I was quite pleased with the HA-650. It's compact and well-made and offers excellent performance for its price. I think that anyone who buys or uses one will be very happy with it.

. . . WA1CCH

Removing Excess Soldering Flux

Appearance of much otherwise good electronic work is quite frequently spoiled by excess soldering flux on connections, and by the dust that eventually accumulates on the residual flux.

Larger accumulations of natural and synthetic rosin can be removed by careful scraping, followed by use of a solvent on a cotton swab or a small brush. Good solvents, in order of increasing strength, are carbon tetrachloride, denatured alcohol, rubber cement thinner, type cleaner, and acetone. All should be used with caution, with adequate ventilation, and away from flames and hot objects. Carbon tetrachloride will not burn, but oxidizes to phosgene if it falls on a hot object, such as a soldering iron.

Do not use these solvents on plastics without a preliminary test. Some plastics soften on contact with acetone and similar substances.

. . . Donald Ives

(Continued from page 2)

too well, but they are important to DXers. I would say that a lot can be done to make our QSL's more interesting. I know I keep the better ones on the wall of my shack and I like to look up at them when I am working the fellow again. In the past I was gung ho for the card with an interesting design . . . the one that really stands out on the wall. Now I'm swinging to the idea that it is nice to have a picture of yourself, your shack, perhaps your house or even your town on the card.

On my card I have a picture of my mountain shack with all the towers and VHF beams. It makes quite an impression, apparently, because a number of DX stations have particularly mentioned looking at it. Just last night I worked 9L1TL and he said he had seen my card at 9L1HX's! The antennas and towers draw the gasps . . . no one has mentioned the little picture of me and my two Italian Greyhounds on the other side. Aha, that gives me an idea. I'll get out the Polaroid and take a picture of myself holding a gun to my head and print a caption, "Send me a QSL or else."

No DX station has any excuse for not QSL'ing any more. The institution of the QSL manager is well accepted and there are hundreds of fellows waiting to manage someone. Some managers even print up the cards, but this is asking a lot. All a DXer has to do is send in his logs to the manager and everything is done. I know that I much prefer to deal with a manager . . . then I know that I am going to get a QSL. I have too many blank places on my wall where fellows who have promised to QSL haven't. Probably the worst of all in this category has been FY7YL. Ernest earnestly promises QSL cards to one and all, but you virtually have to go to his shack to get one. Some fellows that have sent him ready-made cards waiting only his signature, complete with a self addressed envelope with the right postage in his own stamps haven't gotten a card. Fortunately Monique FG7XL has rescued us from this monster and is busy answering the cards for Ernest. The next time you talk to Ernest try to explain to him about the importance of QSLing . . . it will cost him nothing.

Weaker DX stations get completely covered up by the calling stations and we experience the complete stupidity of many minutes of calling with no one being able to hear whether the DX station is answering or not. It would seem to me that once a DX operator finds himself in this spot he should run not walk for some help and select one of the biggest

signals to MC for him and collect the calls of those trying for a contact. I would further suggest that the MC spend as little time on the air as possible . . . first get everyone on the frequency familiar with what is happening, then ask for the spread out system of ET3AC and log calls. Then read off the calls to the DX station and insist that everyone shut up until called by the DX for a report.

By the way, while on the subject, let's come to an understanding . . . either you are working DX or you are rag chewing. Why try to mix the two? That doesn't mean you can't rag chew with DX, just don't start a rag chew when a DX op is obviously trying to give out reports to a number of stations. And this, to my mind, includes such time wasters as spelling out your city, name, or remarks to the effect that you are going to keep it short because a lot of others are waiting. Give the report, say your 73 and sign off and clear and get away. Make sense? And for heaven's sake don't start asking about QSL's . . . he knows that's what you want. If you don't know where to send the card wait until you are through and ask someone else that has been doing more listening and less talking.

. . . Wayne

Kent A. Mitchell W3WTO
1760 Preston Road
Hagerstown, Maryland 21740

The Conar 800 TV Camera Kit

Once the word gets around, CONAR INSTRUMENTS will undoubtedly find that their introduction of the Model 800 TV camera kit has won them a permanent place in the hearts of Amateur TV experimenters. They have a real winner! Priced at $209.50 in kit form, this is certainly the lowest priced *complete* TV camera on the market today. Included as standard equipment i sa 25 mm, f1.9 lens, with wide angle and telephoto lenses available as optional accessories at a reasonable $36.00 and $28.00 additional, respectively. The all important divicon tube is the popular 7038.

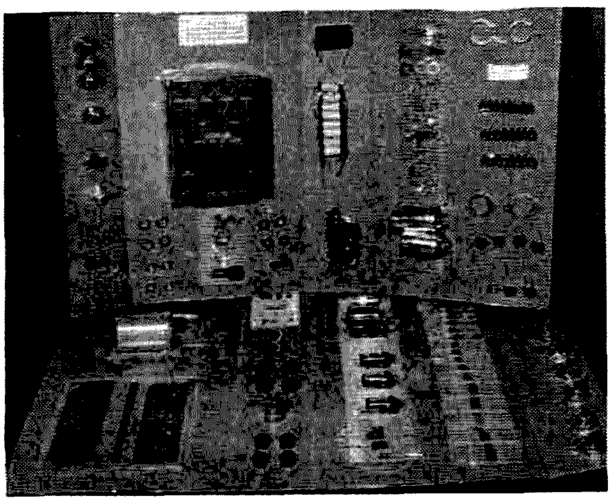
While contained in a small package, the circuitry is not crowded and no problems were encountered during construction. With the exception of the power supply circuits and the rear panel controls, the majority of the components are mounted on a large, heavy foil, etched circuit board. This circuit board certainly contributes to the low assembly time of approximately eight hours. I could find no errors in the construction manual . . . but read

the text carefully and don't just try to see how fast you can place your check marks next to the assembly steps. There are several areas where an inexperienced builder might have to backtrack and reposition some components because the hints hidden in the text were not followed. However, I don't suppose anyone would be building a TV camera as his first construction effort!

The kit arrived at the QTH of W3WTO in a surprisingly small and light package. Being used to watching my delivery-man trudge up the steep slope of my lawn with a kit and appearing to be carrying a carton of surplus cannon balls, I began to wonder if I was getting my money's worth! However, as you know, TV circuits don't require ultra-stable vfo's . . . and their associated boiler-plate stiff chassis, nor heavy high current transformers in the power supply section.

The majority of the kit's components come mounted on three folded 17½ by 30 inch corrugated cardboard sheets and are held in position by a plastic film. The plastic may be stripped away to expose only the components required during a particular phase of construction. Then too, when the evenings work is done, the remainder of the parts may be quickly removed from the kitchen table . . . or wherever else you have been incurring the wrath of your XYL.

Upon completing the assembly of the kit, all the controls are pre-set to approximate positions as per the instruction manual, a TV receiver is connected to the camera output cable, the camera power switch is placed to the ON position, and a hex alignment tool is utilized to adjust the camera rf oscillator slug-tuned adjustment to any desired channel from



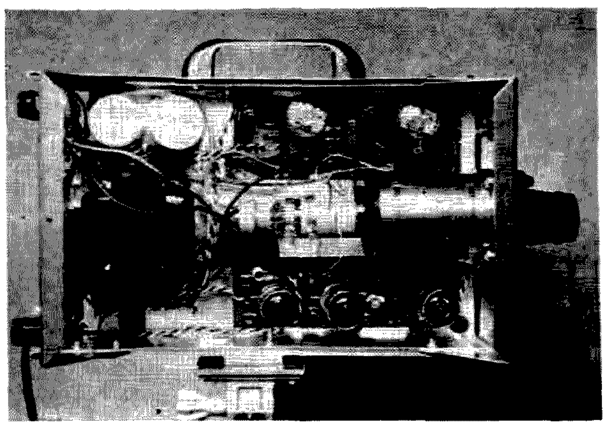
Here's what comes in the Conor TV kit. All parts including the expensive lens and vidicon are included.

Specifications

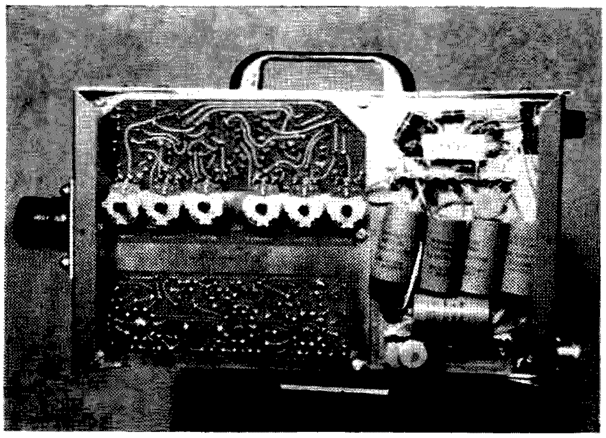
Horizontal Sweep Rate	15,750 Hz nominal
Vertical Sweep Rate	60 Hz (line locked)
Scanning	Random interlace, 2:1 ratio, 525 lines per frame, 30 frames per second.
Sync and Blanking	Combined sync and blanking signals.
Scan Failure Protection	Beam defocussing in the event of horizontal scan failure.
Output	100,000 μV of modulated rf on an adjustable carrier frequency of channel 2 to channel 6 (±2 MHz bandpass) into an output impedance of 75 ohms, unbalanced.
Resolution	240 lines (3 MHz)
Standard Lens	25 mm, f 1.9, focussing 2' to infinity.
Dimensions	5" X 7" X 12-¼"
Weight	11 pounds
Kit Price	$209.50

2 through 6. Next the HORIZONTAL control is adjusted until the camera sweep is synchronized with the TV receiver. Then, the vidicon tube is inserted into its socket, and the TARGET, BEAM, and FOCUS controls are adjusted carefully until . . . there it is!! A beautiful, clear, video picture! The thrill of looking at your first home grown video is almost akin to that of the reply to your first long shaky CQ.

Including the vidicon, there are only six tubes in the camera. The video output of the 7038 vidicon (VI) is amplified by the dual sections of the two 6U8 video amplifiers (V2 and V3) and applied to the grid of the triode section of still another 6U8 (V4A). The second half of the 6U8 (V4B) is functioning as an electron-coupled ultra audion rf oscillator. The oscillator output is coupled to the cathode of the triode section where the rf is modulated by the video. The vertical sync pulse for the camera is developed in a clever little circuit consisting of the neon pilot lamp which is



Here's the vidicon side of the camera assembled. Watch 73 for complete instructions for setting up your own amateur TV station.



You can see from this side view that most of the parts are mounted on an etched circuit board.

fired by 60-hertz ac from the secondary of the power supply transformer and the resultant spike is utilized to drive vertical discharge tube (V5A), one half of a 6FD7, to cut-off . . . producing a more husky and better shaped pulse with which to work. The pulse, as developed across the cathode resistor of V5A, is utilized as the vertical sync pulse and the blanking pulse for the vidicon. The same pulse, as developed in the plate circuit of V5A, is coupled through a long time-constant resistor-capacitor circuit to produce a saw-tooth waveform which, when amplified by V5B and applied to the vertical deflection yoke, becomes the vertical sweep. The horizontal sweep is generated by a free running multivibrator (V6A and V6B) set to approximately 15,750 cps and is applied to the horizontal deflection yoke. Should the multivibrator cease to function, the cathode current of V6B increases and since the vidicon focus coil is in series with the cathode circuit, the vidicon electron beam is defocused so that a spot will not be burnt on the target area of the tube.

After you have your camera in operation and adjusted to your satisfaction, and everyone in the family and neighborhood have made faces at themselves on the living room TV, you are ready to carry it into the ham shack for its first exposure to ATV . . . which of course means modification! However, in this case we are only speaking about the addition of a second coax jack to the rear panel of the camera so that the video may bypass the camera's rf stage and connect to your 440 mc transmitter. The video should be tapped from the grid of modulator V4A. Adequate room to mount a BNC type coax jack may be found just above the rf output jack.

See you on TV!

. . . W3WTO

The total population we found on the Aldabras were about 20 people practically 100% men. One old man I met there had been born on Aldabras some 80 years before and left the island only once, going to Mahe for only a few days. He told me he had no desire whatsoever to leave the Aldabras and see the outside world. This old man had been employed all his life on Aldabra, was sending his salary to Mahe where it was being invested for him. They said he had become quite wealthy. Can you imagine his outlook of the world? His entire world was the Aldabras and nothing else, and HE WAS VERY HAPPY. All the employees on the island are usually on an 18 month work contract to the island leasee, and are fairly well taken care of. If they don't smoke they have no use whatsoever for any money. The leasee of the island furnishes them with food and all the fish they want is also furnished them. Many other items from the sea are also furnished them, they just don't need any money at all. Most of them work hard at their 18 month contract and go back to Mahe (so I have been told) and have one or two weeks of drinking, and running around, until they are flat broke and are then ready to come back for another 18 month contract. Either to Aldabras, Farquahar, Chagoes etc. These fellows are a happy-go-lucky lot and none of the worries of the outside world bother them at all. Maybe this old fellow who was born on Aldabra has a good thing at that. There is nothing like a store on the island so you need no money.

Every night about 7:30 PM everyone gathers around the front door of the manager's and listen to the radio belonging to the manager, usually listening to Mombassa, Nairobi, Tananarive, Ceylon or at times even London.

Gus Browning W4BPD
Orangeburg, S.C.

Gus: Part 15

He has a small Japanese transistor set with short wave. These people have a good life with no worries about anything. All you need to wear on the island is a pair of short shorts. The temperature is absolutely perfect during the days and nights, I estimate it varies from 75 at night to about 90 during the daytime. If you like sea shells they are there just waiting to be picked up.

After Harvey and Jake finished eating they departed for the boat. They were going to hunt a sand bar on the other end of the island and beach the boat and repaint it from stem to stern. Since it was very high tide, and the full moon was due that night, they would not have to go too far up on the beach to be sure the boat was high and dry for they wanted plenty of time to do the boat all over. Harvey was going ashore with his tent and set up his operation from there with his wind charger, etc. They told me I would have about 14 days to operate while they were awaiting the next very high tide so they could float the boat again during the height of the tide that was about two weeks off. This suited me fine—boy 14 days of hamming from Aldabra, that suited me 100%.

After they had departed with plenty of help from the islanders I soon had up my antenna. During this DXpedition I only had horizontal dipoles. I knew nothing about the Hy-Gain Antenna Company and their fine all band vertical ground plane antennas. I wish I had known about them because I am sure I would have put out much better signals than I did. I asked the manager in what direction did the sun rise and set. Not having a compass with me I took his word and got the dipole up broadside to Europe and the USA. The old putt-putt was fired up and VQ9AA was on the

air.

The fun began immediately, I mean to tell you I did business with a bang, it was one solid pile-up for over 12 hours without a let up. When I first got going, the island manager came to visit me, wanting to show the visiting American the island, its turtles, birds, etc. I could see that this fellow had the wrong impression of why I was there. He took me to be a tourist, I turned off the putt-putt and told him I wanted to have a good talk with him. We sat down on the back porch where my equipment was installed on the eating table of the guest house. I explained to him what ham radio was all about, telling him about DXers, telling him that Aldabra Island was one of the rarest spots on the world and that thousands of people all over the world were standing by to QSO me while I was there. I explained to him that lots of the expense of my getting there was paid by these fellows, and since I was an honest fellow I was obligated to do NOTHING BUT OPERATE while I was on the island. I told him if things sort of quieted down that I MIGHT HAVE TIME later on to do some visiting of the various parts of the island. I told him all I wanted to do was to sit at my operating table, hour after hour, day after day, and work the boys one after another until I had worked them all. I even asked him to have my meals at certain odd hours, during times I thought the bands' activity would be at their lowest. After that I had no more trouble with him wanting to show me around the island. After about 3 days operation I happened to notice EXACTLY where the sun settled into the sea and to my surprise it was not at the spot indicated to me before. My antennas were not broadside to Europe or the USA, they were off the ends.

The next day I changed this and all signals picked up about 2 S points from Europe and the USA. Another must for DXpeditioners—bring along your own compass and let it tell you where to squirt your signals. Don't take the words of anyone as to where is East and West, most of them don't know, they just think they do. Things were going fine with me. The food was very fine. Have any of you ever eaten real turtle steak or turtle liver? Or scrambled turtle eggs? The turtle steak is about twice as tender and twice as white as veal cutlets. The livers from these turtles are out of this world and could be cut with your fork. The eggs were about 75% yolk and were very fine when scrambled. I never did get tired of eating turtle meat, etc. Fish were prepared in many different ways. Fried, fish soup,

boiled fish, baked fish, fish curried and rice being very nice. They eat plenty of rice there and since I was from one of the rice eating parts of the world, I was right at home with it piled up high on my plate. Certain parts of coconut trees were nice, when boiled in soups, as well as bamboo shoots. I even had some sea shell soup, the sea shells are placed in boiling water, the meaty part cooked and then it sheds away from the sea shell. Maybe some people call this snail soup. They like plenty of pepper in their food. After explaining to my cook I did not like pepper he cut down from 195 degrees of pepper to about 125 degrees, explaining that he could not cook anything with less pepper. After a while my mouth got tough enough to take it OK.

I tried listening for Harvey, and finally heard him on about 14085 kHz about S 3. We were separated far enough apart so that we caused each other no QRM whatsoever since I had always used 14065 or 14035 kHz when on CW and about 14125 plus or minus when on SSB.

After about 3 days of operation my power plant konked out. Have you ever tried taking off the cylinder head of an engine with only a pair of regular pliers? Well I did. After cleaning off the surplus carbon, adjusting and cleaning the spark plug and even trying to clean up the valves the engine was put back together and still it was dead as a door knob. Plenty of spark was on the plug so it had to be the fuel system. Off came the carburetor and apart it came. One valve seat was completely plugged shut, this was cleaned and while trying to force the carburetor back together something went "crack." Apart came the carburetor again and I found that I had broken one of the needle valves that was made out of Teflon. No spare parts were along with me. It was either repair this broken needle valve or no more VQ9AA operation. I had my electric soldering iron with me but no electric current to heat it with. Try heating up your electric iron with 4 candles as I did. By being very careful I welded the Teflon needle valve back together, smoothing the welded spot with the hot iron, found that the carburetor gasket had got broken and found that a call book cover made a FB gasket for the carburetor. Back together went everything, and the putt-putt cranked up immediately, and I was back in business. The moral to this story for you future DXpeditioners—bring along at least some small spare parts and a few tools to take your power supply engine apart with. This is a MUST in my book.

At about sundown time on my first night on

Aldabra I was on the air with a big pile-up and all of a sudden I heard the doggondest noise outside. Flapping wings, squawking, screeching, thuds, etc. I rushed outside to see what was causing all this commotion and there were birds by the hundreds in what seemed to be a free-for-all. After watching this battle royal for a while I soon saw the pattern of what was taking place. The booby birds that were out fishing all day, filling their craws full of little fish for their young on Aldabra were coming home at sun-down and the other birds (let's call them falcons—they have another name; I forgot what it is) would hover way up high, spot a certain booby coming in about 50 feet above the water. The falcon would close his wings and down he would come like a stone, hitting the booby bird in the middle of his back, almost knocking the booby bird breathless I guess, this sudden jolt would cause the booby to heave up its crawful of little fish, the falcon would then curve up under the booby and grab a big mouthful of fish that had been spewed from the booby. This little episode took place every evening just before darkness came and it was better than Red Skelton on TV. I never did see any booby get thru with his crawful for the young. I was told that this has been studied and about 3 to 4% of the boobies do get thru. Whoever named these birds booby birds certainly selected a very descriptive name for them. They certainly are a booby to fish every day for the falcons to get their catch without working for it.

I soon settled down to a sort of regular operating schedule. About 5:30 AM (all these times local) I would get up, crank the power plant up, work the fellows until the band sort of leveled off at 10:00 AM; then eat breakfast; in the sack until about 2 or 3 PM, then it was dinner and on the air until about 2:30 AM a late snack to eat and to bed with the alarm clock set at 5:30 AM. This gave me enough sleep and still satisfied the gang with enough activity and openings for everyone.

After the first week the big pile had been worked down to a small one and I began to have more time to look around the island like a good tourist should. I was shown the turtle pond where they kept usually around 200 of those big turtles awaiting the boat from Mahe which came when it was available. No certain schedule at all but usually every 3 or 4 months to pick up the live turtles and take them on deck back to Mahe where they were put into the turtle pond there and sold as they were needed. Fishing on Aldabra is done on what looked to me to be a large scale. Each

boat went out every day and caught a boat full of fish. It did it the hard way, by spearing the fish. When the fish are brought ashore they are cleaned up, covered with what looked like ice cream salt and put out in the sun to dry. Later on this dried fish is sent back to Mahe to be used there and some shipped probably to Africa. Copra (dried coconut meat) is done on a fairly large scale, too. No one seemed to be working very hard. They have a certain amount of work to do each day and most of them could do their daily task in about 6 hours. Of course a few eager beavers worked longer for extra consideration. But this was the exception rather than the rule.

I finally had a QSO with Harvey who was operating from the other end of the island and was told that we were going to stay there for a total of 17 days—this was indeed FB news for me. If there is ever a repeat of Aldabra I will be prepared for some 40 and 80 meter operation and thereby hand out a new country to everyone on these bands. Maybe even 160 meters. Conditions seemed very good to me while I was there, I wonder how they would sound if I were there during the good part of the sunspot cycle? Can you picture the stations you could work from there when 10 meters thru 80 opened up. Around the clock openings would really work a fellow to death. But what a FB way to die? Hi, Hi!

While on Aldabra I got a message from Peggy thru Ack that we had to build a new house. It's a long story about a land deal I will not take the time to repeat on these pages. But on account of a deal on land Peggy said a new house had to be built. I told her to go ahead and build it and to not forget THE HAM SHACK. Let me tell you I did get a ham shack built too. A lot larger and nicer than I would have had the nerve to build myself. Peggy even got my 150 tower taken down and the 5 element beam taken apart too. Boy I really found out what a nice XYL I had and to this day she has not changed in the least—in fact she gets better all the time, still bringing my breakfast into the ham shack each morning, and even supper if I ask her to. There just aren't many like good old Peggy, this I am sure of. How many of you fellows' wives would let you leave them for first 7 months, then for TWO YEARS? I think the percentage would be below 1%. Peggy says to me her first obligation in our marriage is to make me happy and she likes to also make others happy and this is her method of doing just this.

Coaxial Accessory Handbook

Jim Fisk WA6BSO

In addition to the coaxial cable and connectors required in a coaxial transmission system, coaxial relays, switches, standing wave meters, attenuators and dummy loads are often included as operating conveniences. When choosing these coaxial accessories, the operating parameters should be evaluated in exactly the same way as for the cable and connectors. If the selected accessory exhibits excessive power loss or results in a large standing wave ratio, deterioration in transmission line efficiency may be expected.

Coaxial relays

Of all the coaxial accessories available, the coaxial changeover relay is probably the most important. In almost every amateur station where a coaxial transmission line is employed, some type of coaxial relay is used to switch the antenna between the receiver and transmitter. However, the indiscriminate selection and use of a coaxial relay may lead to problems, particularly in the VHF or UHF bands or when using a transistorized rf stage in the receiver.

Generally speaking, coaxial switches may be grouped into two general categories, depending upon the switching mechanism. The more familiar of these is the bladed variety, in which the center conductor of a coaxial section is actuated by a solenoid. Most relays in current use are of this type. In the second category, a moving coaxial section (both inner and outer conductors) transfers rf power by solenoid actuated rotation. This switch is the more complex of the two and is normally used only at frequencies above 500 mc.

The contact arrangement most commonly found is the single pole, double throw (SPDT) type, but other arrangements are available for special applications. Most coaxial relay manufacturers will provide additional auxiliary contacts at a slightly higher cost. These contacts are useful for switching other circuits simultaneously with the antenna.

Once the basic type of switch and the required contact arrangement have been determined, the standing wave ratio, insertion loss and isolation of the switch should be reviewed.

The standing wave ratio is the major element of transmission efficiency through the switch. Basically, it is a comparison of the characteristic impedance of the switch to that of the transmission line into which it is installed. For most amateur applications, an SWR up to 1.5 or occasionally 2.0 is satisfactory, but seldom greater than 2.0:1.

Crosstalk is another important consideration. This is a measure of the rf leakage between the used and unused contacts of the relay. This relative isolation between contacts is expressed in "decibels down," meaning the leakage signal is down to some percentage of the operating signal. Since crosstalk is a result of the capacitive coupling between the operating and unused circuits, it increases at high operating frequencies (i.e., as the capacitive reactance decreases). At 400 mc, the single bladed coaxial switch exhibits typical crosstalk of 40 db down. To reduce crosstalk further, it is necessary to employ shorting contact construction in which the unused connector is terminated in a short-circuit. This is an absolute necessity when transistorized rf amplifiers are used in the receiver. The Dowkey DK-60G coaxial relay is of this type construction and exhibits greater than 100 db isolation at 500 mc.

Insertion loss is a measure of the power loss within the switch itself and is expressed as:

$$\text{Loss in db} = 10 \log \frac{(\text{power output})}{(\text{power input})}$$

This loss includes the resistive loss of the con-

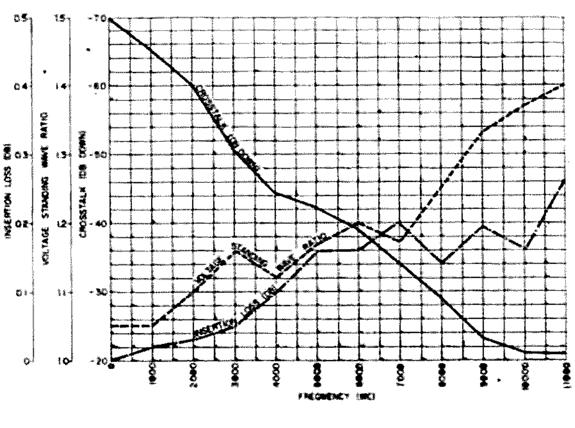


Fig. 1. Typical operating characteristics of the Transco Series-Y coaxial switches.

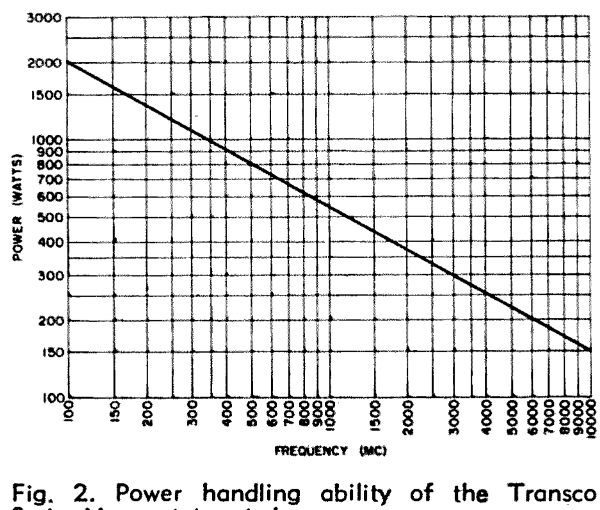


Fig. 2. Power handling ability of the Transco Series-Y coaxial switches.

Table 1. 50 ohm Coaxial Changeover Relays

Manu-facturer	Switch Type	Model Number	SWR	Maximum Frequency	Power (watts)	Auxiliary Contact	Solenoid Voltages	Connector Types
Advance	SPDT	CB/1C	–	300	–	Yes	12, 24 VDC, 115 VAC	UHF
Amphenol	SPDT	315	1.15 at 500 mc	1000	100 at 1000 mc	No	6-120 VDC or AC	BNC
Amphenol	SPDT	316	1.20 at 2200 mc	2750	100 at 2750 mc	No	6-120 VDC or AC	BNC
Amphenol	SPDT	316	1.20 at 2400 mc	4000	100 at 4000 mc	No	6-120 VDC or AC	N
Amphenol	SPDT	317	1.20 at 2200 mc	2750	100 at 2750 mc	No	26 VDC, 115 VAC	BNC
Amphenol	SPDT	317	1.20 at 2400 mc	4000	100 at 4000 mc	No	26 VDC, 115 VAC	N
Amphenol	SPDT	318	1.20 at 2200 mc	2750	100 at 2750 mc	No	26 VDC	BNC
Amphenol	DPDT	321	1.15 at 500 mc	1000	100 at 1000 mc	No	115 VAC	BNC
Dow-Key	DPDT	DK2-60	1.15 at 500 mc	500	1000 at 500 mc	Yes	6-220 VDC or AC	BNC, N, C, UHF
Dow-Key	SPDT	DK-60	1.50 at 500 mc	500	1000 at 500 mc	Yes	6-220 VDC or AC	BNC, N, C, UHF
Dow-Key	SPDT	DK-61	1.10 at 400 mc	1000	100 at 1000 mc	Yes	6-220 VDC	BNC
Dow-Key	SPDT	DK-67	1.30 at 2000 mc	2000	100 at 2000 mc	Yes	6-220 VDC or AC	BNC
Dow-Key	SPDT	DK-77	1.10 at 400 mc	1000	250 at 1000 mc	Yes	6-110 VDC	BNC
Magnecraft	SPDT	128	1.25 at 500 mc	500	100 at 400 mc	Yes	12, 24 VDC, 115 VAC	UHF

tacts, the dielectric loss of the insulators and any reflective loss due to impedance discontinuities. The dielectric loss is normally quite low in modern coaxial relay design and the resistive and reflective losses contribute most to the overall insertion loss of the unit. The resistive losses are minimized by using short, silver-plated conductors but the reflective loss is more difficult to control, especially at high frequencies. However, up to about 1000 mc, the insertion loss of well designed coaxial switches is negligible when compared to the transmission lines with which they are used.

Most coaxial relay manufacturers have a wide assortment of units available which will satisfy nearly any application. These relays may be furnished with 6 volt to 220 volts ac or dc solenoids, UHF, BNC, N, or C connectors, power ratings up to 1000 watts at 1000 mc and low standing wave ratios up to 10,000 mc. Although the Dow-Key line of coaxial relays probably finds the greatest use in amateur stations because of their wide availability and relatively low cost, other manufacturers include Advance, Amphenol, Magnecraft and Transco. **Table 1** lists the operating characteristics of the major types of coaxial relays available from these manufacturers.

Whereas most of the switches in **Table 1** are of the leaf variety, the Transco relay uses a moving coaxial section for greater power handling, isolation and low SWR characteristics up to 11,000 mc. This unit was designed to meet the requirements for a small, lightweight, coaxial switch having good rf characteristics over a broad bandwidth and is widely used by the military. In the Transco switch, two independently operating solenoids allow either make before break or break before make operation. Also, rf positions may be both on or off simultaneously. For the UHF enthusiast the surplus Transco switch offers superior operating characteristics at a modest cost. Typical operating and power handling properties of this unit are shown in **Fig. 1** and **2.**

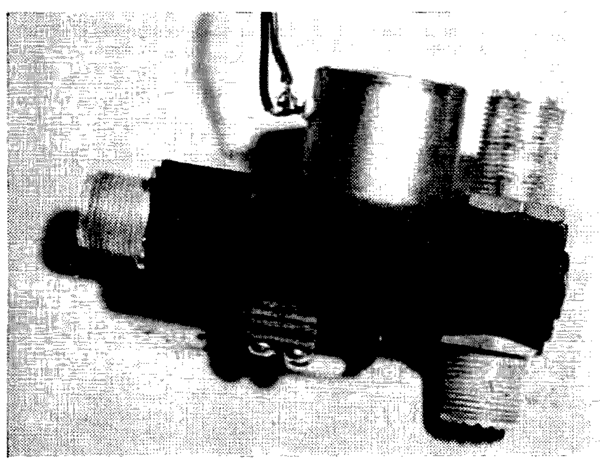


Photo by WA6IAK.

The Dow-Key Model DK60-G2C coaxial relay. The design of this unit is such that it provides excellent isolation up to 500 mc with minimum insertion loss.

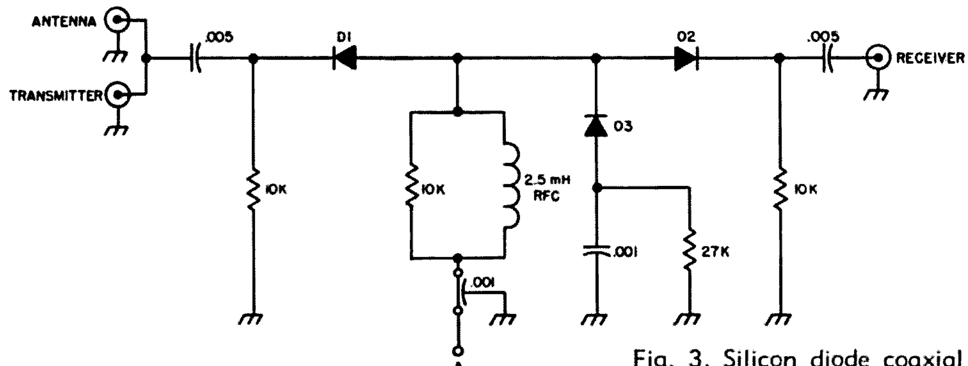


Fig. 3. Silicon diode coaxial antenna switch. This switch provides more than 80 db isolation with less than 2 db insertion loss.

Although the coaxial type of changeover relay seems like the simplest and most direct way of switching the transmission line from transmitter to receiver, it is somewhat noisy and in some cases, slow. There have been several electronic T-R switches introduced over the past few years, first with vacuum tubes and more recently with silicon diodes, which solve these problems. The solid state diode switch for example, is extremely fast, completely noiseless, exhibits up to 80 db of isolation with only 2 db insertion loss and is very simple and economical to build. The simplest of these switches is illustrated in **Fig. 3.** This switch uses three inexpensive silicon diodes, a few bias resistors, several capacitors and a choke to perform efficient switching of coaxial transmission lines up to 30 mc. To understand the mechanics of this switch, it must be remembered that a reverse biased diode presents an extremely high impedance while the forward biased device looks essentially like a short-circuit. With these facts in mind, consider the operation of this three diode switch when a positive voltage is applied to point A; diode D1 and D2 will conduct and present a low impedance while diode D3 presents a high impedance because it is reverse biased. Under this condition an rf signal on the antenna passes to the receiver with very little attenuation.

Photo courtesy Barker & Williamson, Inc.
The B&W electronic T-R switch is an automatic unit that automatically switches the transmission line from receiver to transmitter when transmitting. This type of a switch is ideal for break-in operation and results in substantial receiver gain in most installations.

If a negative voltage is introduced at point A however, diode D1 and D2 will no longer conduct and diode D3 will present a low impedance to ground because it is forward biased. Any rf signal on the antenna is confronted by the high impedance presented by the reverse biased diode D1. A certain amount of rf energy will leak by this high impedance, but the high impedance presented by diode D2 must still be surmounted. A much easier path for the rf exists through the low impedance path to ground provided by diode D3 and the series bypass capacitor. With this type of switching up to 80 db isolation can be obtained with a minimum of effort.

One of the most important considerations in diode switches is the amount of rf power they can safely handle. Actually, there are two separate and distinct ratings that are of interest; peak power and average power. The peak inverse voltage (PIV) rating of the diode determines the maximum peak power that the diode can control. The average power which the diode can safely switch is dictated by its power dissipation and series resistance. Since the series and shunt diode circuits operate in somewhat opposite ways, it would not be unusual to expect that their power ratings might be different. This is in-

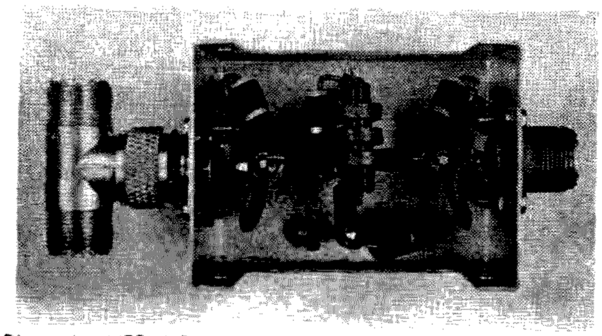


Photo by VE2AUB

This simple silicon diode controlled T-R switch provides more than 80 db isolation and less than 2 db insertion loss from 3.5 to 30 mc. This unit uses three inexpensive silicon diodes and may be easily duplicated in the home workshop.

deed the case and it is interesting to note that although the shunt circuit has twice the peak power rating of the series circuit, its average power rating is only one-quarter as much as that of the series arrangement. For 50 ohm coaxial transmission lines operating with an SWR of 1:1, the respective power ratings may be calculated from the following equations:

Series

Peak power $= (PIV)^2/1600$

Average power $= 25$ Pd

Shunt

Peak power $= (PIV)^2/400$

Average power $= 6.25$ Pd

Where: PIV = Peak inverse rating of the diode (volts)

Pd = Power dissipation rating of the diode (watts)

From these formulas it can be readily found that to control the peak power of a 1000 watt CW transmitter operating at 70% efficiency (700 watts into the transmission line), a series diode would require a PIV of 1058 volts; under the same conditions a shunt switching diode would require a PIV of 529 volts. For insurance against blowing the diodes under peak power loads or SWR changes, a safety factor of 50% should be added to these figures. In the diode switch in **Fig. 3**, both the shunt and series diodes are used, so both of the above power formulas must be considered in using a switch of this type.

The Dow-Key DK1 is an untuned electronic transmit-receive switch for coaxial lines which may be used from 80 through 10 meters.

Coaxial switches

When it is necessary to switch several circuits simultaneously or to increase the number of throws over the simple SPDT coaxial changeover relay, the most straightforward approach is to use a rotary coaxial switch. With these units, switching may be accomplished in a fraction of a second, thereby eliminating the need for screwing and unscrewing coaxial fittings and the possibility of an incorrect connection.

These switches are available in both manual and solenoid operated versions suitable for frequencies up to 1000 mc. Usually the leaf-type wafer switch is used as the switching mechanism, but more expensive types employ a moving coaxial section similar to that illustrated in **Fig. 4.**

Selection of rotary coaxial switches is much the same as that for coaxial relays, with SWR, isolation, and power capacity being the main points of interest. For comparison purposes, the operating characteristics of various rotary

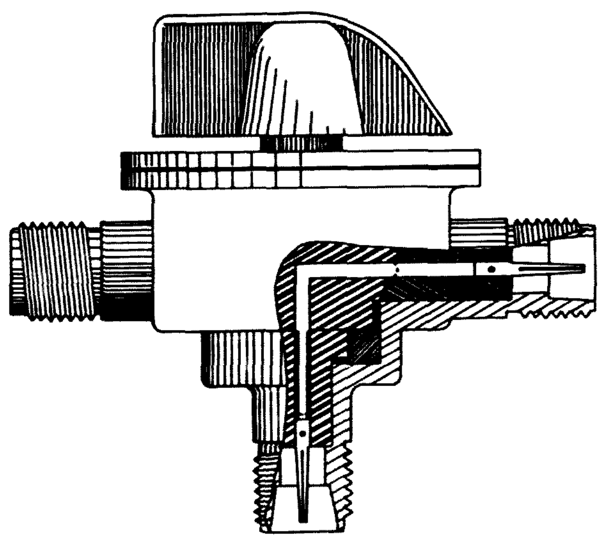


Fig. 4. Cross section of a coaxial switch which has a low standing wave ratio up to several thousand megacycles. Note that both the inner and outer conductors are switched together.

Table 2. Coaxial Switches

Manufacturer	Switch	Model Number	Impedance (ohms)	SWR	Maximum Frequency	Power (watts)	Isolation	Connectors
B & W	SP5T	550A	52 or 75	—	50 mc	1000 at 50 mc	45 db at 30 mc	UHF
B & W	SP2T	550A2	52 or 75	—	50 mc	1000 at 50 mc	45 db at 30 mc	UHF
B & W	Single Transfer	551A	52 or 75	—	50 mc	1000 at 50 mc	45 db at 30 mc	UHF
B & W	SP5T	560	52 or 75	—	50 mc	1000 at 50 mc	45 db at 30 mc	BNC
B & W	Single Transfer	561	52 or 75	—	50 mc	1000 at 50 mc	45 db at 30 mc	BNC
B & W	SP5T	570	52 or 75	—	50 mc	1000 at 50 mc	45 db at 30 mc	N
B & W	SP5T	580	52 or 75	—	50 mc	250 at 50 mc	45 db at 30 mc	Phono
B & W	SP5T	590	52 or 75	—	50 mc	1000 at 50 mc	45 db at 30 mc	UHF
B & W	2P2T	591	52 or 75	—	50 mc	1000 at 50 mc	45 db at 30 mc	UHF
B & W	SP2T	592	52 or 75	—	50 mc	1000 at 50 mc	45 db at 30 mc	UHF
Dow-Key	SPDT	DK78-2	50	1.10 at 500 mc	500 mc	1000 at 500 mc	60 db at 400 mc	UHF, BNC, C, N
Dow-Key	SP3T	DK78-3	50	1.10 at 500 mc	500 mc	1000 at 500 mc	60 db at 400 mc	UHF, BNC, C, N
Dow-Key	SP6T	DK78-6	50	1.10 at 500 mc	500 mc	1000 at 500 mc	60 db at 400 mc	UHF, BNC, C, N
Dow-Key	Single Transfer	DK78-T	50	1.10 at 500 mc	500 mc	1000 at 500 mc	50 db at 400 mc	UHF, BNC, C, N
Dow-Key	SP6T	DK71	50	1.10 at 100 mc	500 mc	1000 at 500 mc	40 db at 100 mc	UHF, BNC, C, N
Dow-Key	SP3T	DK-72	50	1.10 at 100 mc	500 mc	1000 at 500 mc	40 db at 100 mc	UHF, BNC, C, N
PIC	SP5T	PS750	50 or 72	1.2 at 100 mc	100 mc	1000	45 db at 30 mc	UHF
PIC	SPDT	PS751	50 or 72	1.2 at 100 mc	100 mc	1000	45 db at 30 mc	UHF
PIC	Single Transfer	PS752	50 or 72	1.2 at 100 mc	100 mc	1000	45 db at 30 mc	UHF
Sentry	SP3T	—	52 or 75	—	50 mc	250 at 50 mc	—	UHF
Waters	SP6T	335	50	1.20 at 150 mc	150 mc	1000	—	UHF
Waters	Single Transfer	336	50	1.20 at 150 mc	150 mc	1000	—	UHF
Waters	SPDT	341	50	1.20 at 150 mc	150 mc	1000	—	UHF
Waters	Dual Transfer	351	50	1.20 at 150 mc	150 mc	1000	—	UHF
Waters	SP6T	375 Protax	50	1.2 at 150 mc	150 mc	1000	—	UHF
Waters	SP5T	376 Protax	50	1.2 at 150 mc	150 mc	1000	—	UHF
Waters	SP5T	378	50	1.2 at 150 mc	150 mc	1000	—	UHF

coaxial switches are listed in **Table 2.** The majority of coaxial switches currently available fall into one of the six basic switching configurations illustrated in **Fig. 5.**

Selector switches were designed primarily for switching the output (or input) of a coaxial transmission line between various antennas, or dummy loads. However, they may be used in any installation where similar type switching is desired. The single transfer

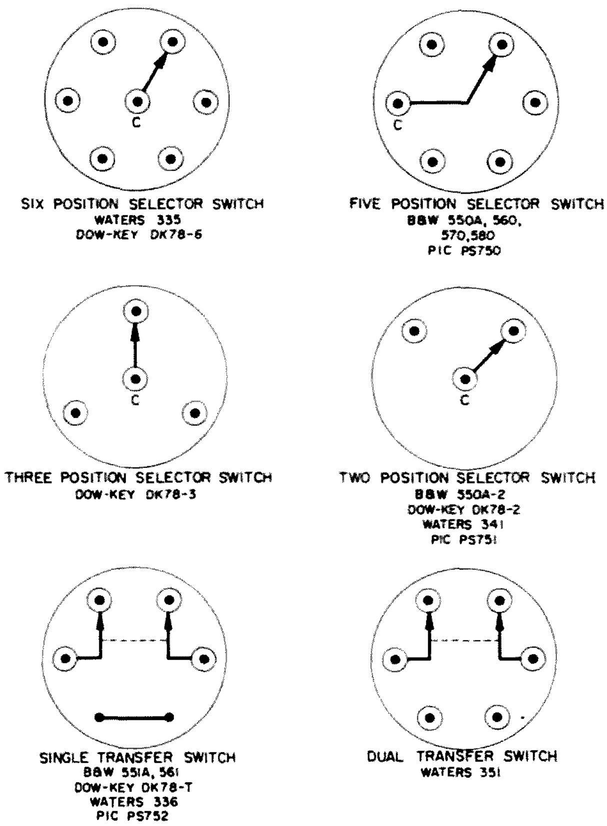


Fig. 5. Switch contact arrangements of commercial coaxial switches.

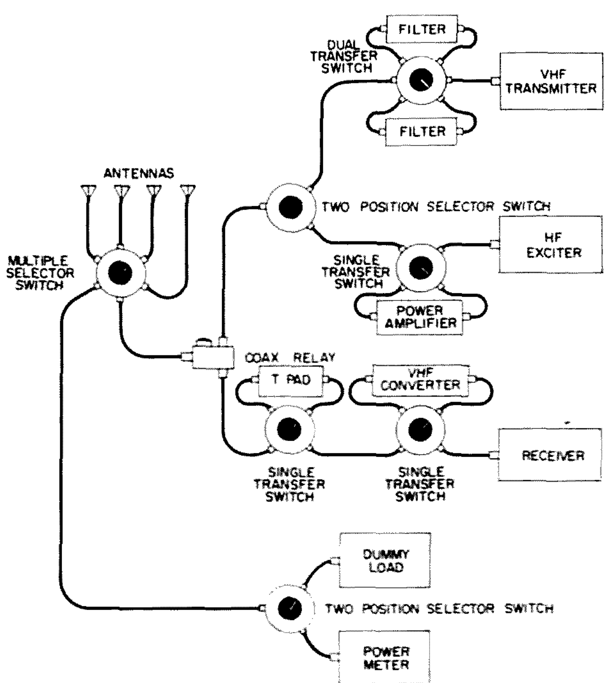


Fig. 6. A typical coaxial switching arrangement, with all the coaxial switching requirements of a ham station being accomplished with coaxial switches. This arrangement is much handier than screwing and unscrewing fittings every time you want to change a cable.

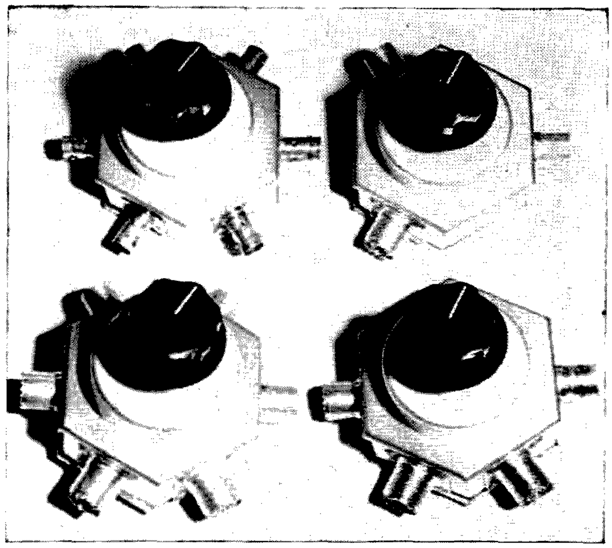


Photo by WA6IAK.

Several Barker and Williamson coaxial switches. Clockwise from the upper left: Model 560 with BNC connectors, Model 550A2 with UHF connectors, Model 551A coaxial transfer switch and Model 550A with UHF connectors.

switch is intended for switching various devices in or out of series connection with low impedance coaxial lines. Some of the uses are switching antenna current meters, antenna tuning devices, baluns, etc., in or out of the antenna feedline system. They may also be used to switch coaxial coupled power amplifiers in or out of the antenna circuit at will, thereby permitting the exciter to be connected directly to the antenna during local communications. The dual transfer switch is useful in switching converters, filters, etc., in

Photo courtesy Polyphase Instrument Co.

The PIC Polyswitch is a compact rf switch of modern design which may be used with a full 2 kilowatts PEP up to 100 mc. These switches are available in three basic models which will satisfy nearly any requirement.

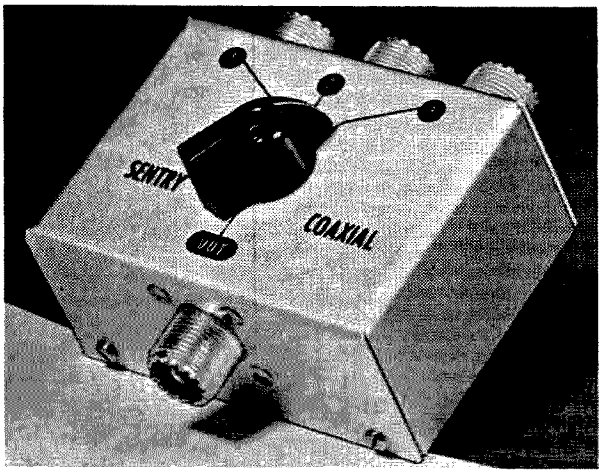


Photo courtesy Sentry Manufacturing Co.

The Sentry SP3T coaxial switch may be used to switch up to three coaxial transmission lines. It is furnished with standard series UHF connectors and will handle up to 250 watts of rf power.

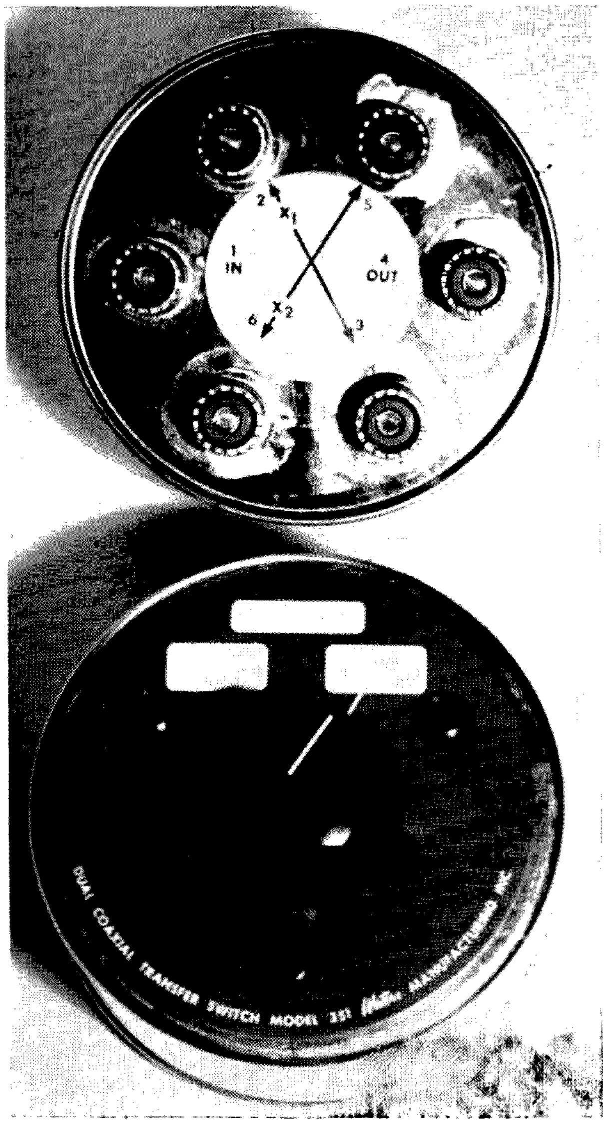


Photo by WA6IAK.
The Waters Model 351 coaxial transfer switch.

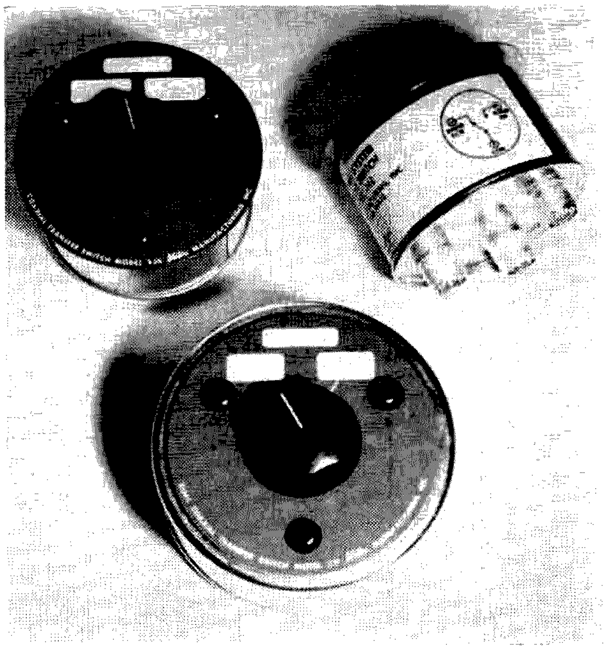


Photo by WA6IAK.
Several Waters coaxial switches. Clockwise from the upper left: Model 336, Model 341 and Model 351. All these switches are equipped with series UHF connectors.

and out of the transmission system. Some typical applications for these switches are depicted in **Fig. 6.**

In addition to their normal line of single section coaxial switches, Barker and Williamson offers multiple gang types where up to six single gang switches may be connected in tandem. This arrangement is especially useful where several circuits must be switched simultaneously.

The operating characteristics of the Dow-Key coaxial switches are charted in **Fig. 7.** These switches do not use the simple wafer switch as the switching mechanism and offer excellent rf characteristics up to 500 mc. In

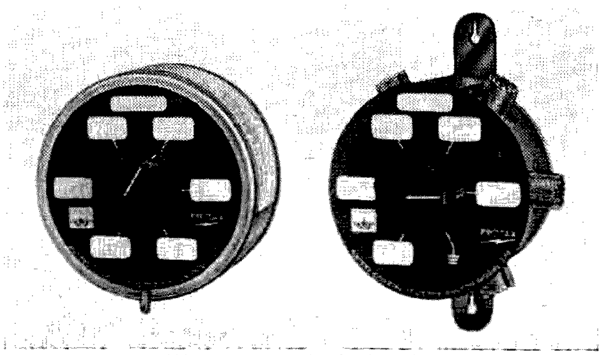


Photo courtesy Waters Manufacturing Inc.
Waters' Protax™ coaxial antenna switches are designed to ground all the station antennas when the rig is not in use. The Model 375 on the left is made for panel mounting and has six connectors mounted in the rear. The Model 376 on the right has five side mounted connectors and is made for wall mounting.

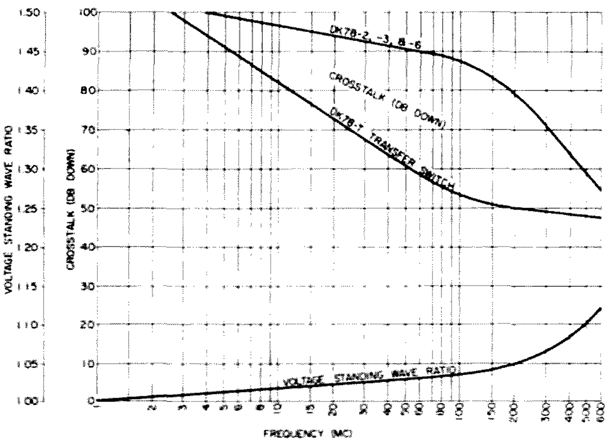


Fig. 7. Typical operating characteristics of the Dow-Key coaxial switches. Note that these switches provide low standing wave ratios and high isolation even at 500 mc.

addition to their manually operated switches, Dow-Key offers electrically operated units that may be used for remote switching of antennas, transmission lines or other equipment. These switches (series DK71 and DK72) exhibit essentially the same operating characteristics as the DK78 series (**Fig. 7**). These units are in waterproof housings with mounting straps suitable for direct installation to outdoor antenna masts. With this type of installation, up to six antennas may be fed with one coaxial line.

The Polyphase Instrument Company (PIC) offers several compact coaxial switches that will handle up to 1000 watts at moderate rf frequencies. The main advantage of these switches is their small size.

Waters coaxial switches are mounted in sealed metal cases and are furnished with an appropriate self-marking escutcheon plate and molded phenolic knob. These switches are furnished with UHF connectors mounted on the rear side of the switch; this connector arrangement minimizes behind-the-panel installation space and eliminates the necessity for auxiliary coaxial elbow fittings. Waters switches are rated at 1000 watts and exhibit an SWR of less than 1.2:1 up to 150 mc.

A recent addition to the Waters line of coaxial switches is the "Protax." Basically, this model is two switches in one; a regular antenna selector switch with a rating of 1000 watts and an auxiliary contact for grounding all antennas (leaving the receiver input open) when the transmitter is not in use. This arrangement is designed to minimize the danger of injury or fire during electrical storms. Protax switches are available in either five or six position configurations with UHF type connectors.

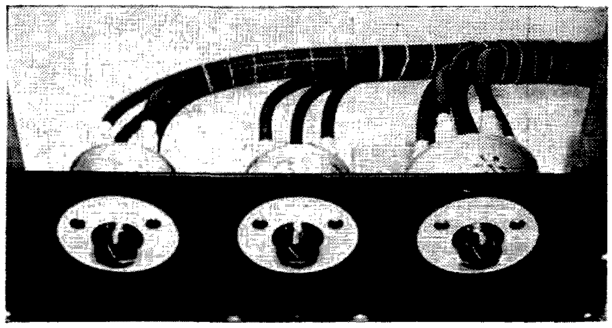


Photo courtesy Waters Manufacturing Co.

A neat coaxial switch installation. These switches are arranged for switching the receivers, transmitters and antennas in a typical amateur station.

Standing wave meters

One of the most convenient methods of monitoring coaxial transmission line operation is the standing wave meter. There are many devices available for this purpose as indicated in **Table 3**, but most of the currently available units use the familiar "monimatch" design introduced in the 1950's. Standing wave meters built using this principle may be left in the transmission line at all times without affecting line performance.

It is essential to the understanding of the directional coupler or reflectometer type of standing wave meter to realize that the current and voltage of the rf power propagating along a transmission line toward the load are in phase. On the other hand, it must be further understood that the reflected components of voltage and current are exactly 180 degrees out of phase. This may be a little difficult to envision, but none the less it is true, and al-

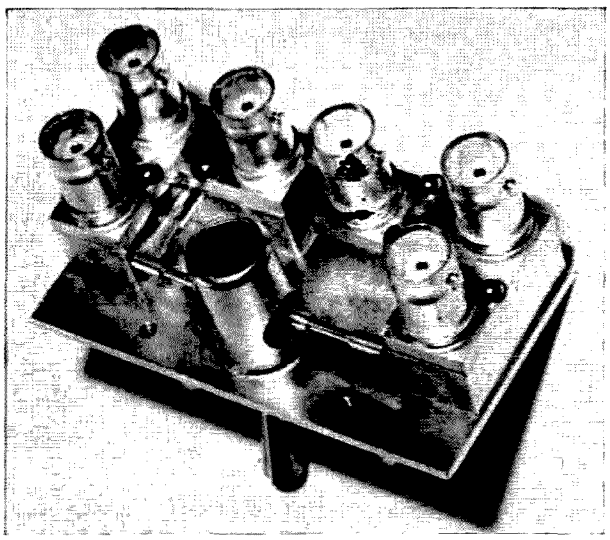


Photo by WA6IAK.

A surplus coaxial switch that is actuated by a toggle lever. This switch has excellent operating characteristics and may be used up to several thousand megacycles.

though it is beyond the scope of this handbook to explain wave mechanics, complete details have been included in many articles and in most antenna and transmission line handbooks.

When the load is perfectly matched to a transmission line, all the power which is transmitted toward the load (incident) is dissipated by the load. If the load does not match the transmission line however, a portion of the incident or forward power is reflected; the reflected components of voltage and current combine with the forward components to produce standing waves. The standing waves are so called because they have a fixed position for any given load impedance. When the reflected and incident components combine, a voltage (or current) maximum occurs where the two components are in phase, and where they are out of phase, a minimum occurs.

The directional coupler takes advantage of the fact that the forward components are in phase while the reflected components are 180 degrees out of phase. The pickup unit which most manufacturers are currently using was originally developed by the Naval Research Laboratories[1] and popularized by W1ICP.[2] This device uses a pickup wire which is parallel to the inner conductor of the coaxial line as shown in **Fig. 8**. Different manufacturers use various constructional techniques, but the principle of operation remains the same. Since the pickup wire is parallel to the inner conductor of the transmission line, a small voltage is induced in it by inductive coupling. At the same time, the voltage on the transmission line is sampled by capacitive coupling of the pickup wire; due to this voltage, a current flows through the terminating resistor and there is a voltage developed across it. When the layout of the pickup unit is such that the forward components of voltage and current cause these two voltages to be in phase, the resultant output is indicated on the meter. The reflected components would have no effect on this pickup line because the two voltages would be out of phase and cancel each other out. To detect the reflected components, another pickup line has to be constructed with the terminating resistor at the opposite end; the forward components would have no effect on this line of course because the two voltages would again be out of phase and cancel out. Although the effect of both the inductive and capacitive portions of the pickup line vary with frequency, their ratio remains the same. This just means that this type of a unit is more sensitive on the higher frequencies.

Usually when designing or building a standing wave meter, the pickup unit should be made much shorter than a quarter wavelength long. The only other precaution lies in the selection of the terminating resistors. First of all, if they are too large, they will introduce a phase error in the voltage pickup and cause poor nulls. On the other hand, if it is too small,

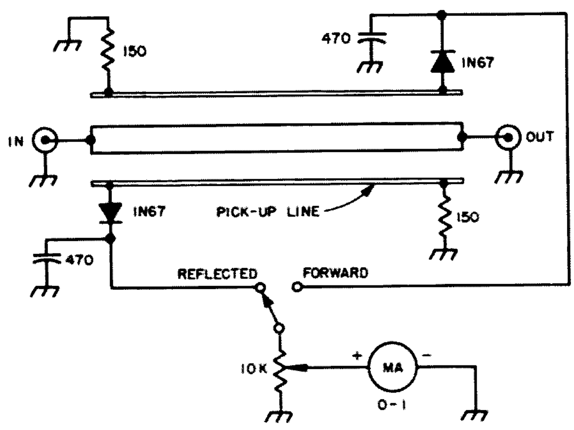


Fig. 8. Schematic of a pickup unit for the directional coupler type of swr meter.

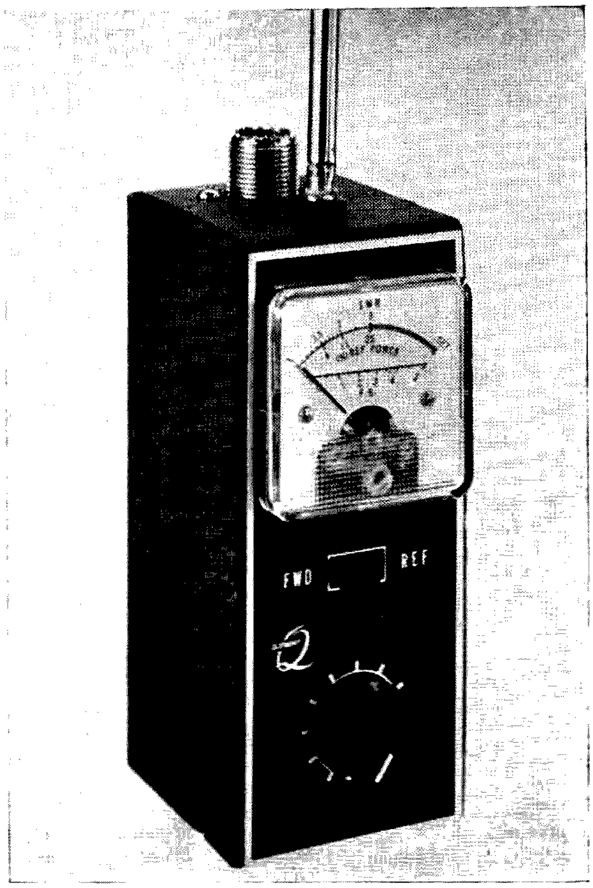


Photo courtesy Quement Electronics.

Quement Electronics' combination swr bridge and field strength meter is a compact and versatile instrument. In addition to swr measurements in 52 ohm lines, it serves as a field strength meter with the antenna provided.

Table 3. Standing Wave Ratio Meters

Manufacturer	Model Number	Impedance (ohms)	Connector Type	SWR Range	Maximum Power (watts)	Frequency Range (mc)
Ameco	BIU	52	UHF	20:1	1000	1.8 - 225
Bird	Thruline	50	N, C, UHF	∞:1	5000*	2.0 - 2300
Cesco	CM52	52	UHF	100:1	1000	3.0 - 200
Cesco	CM52-2	52	UHF	100:1	1000	3.0 - 200
Heathkit	HM-15	50 or 75	UHF	3:1	1000	1.8 - 56
M. C. Jones	250	50 or 72	N, C, UHF	20:1	500	3.0 - 225
M. C. Jones	260	50	N, UHF	20:1	1000	0.5 - 225
M. C. Jones	300	50	N, C, HN	20:1	120	25 - 2000
M. C. Jones	500	50	N, C, HN	8:1	1200	20 - 2000
M. C. Jones	590	50	N, C	8:1	120	1000 - 3000
M. C. Jones	700	50	N, C, UHF	100:1	1200	20 - 1000
M. C. Jones	720	50	N, C	15:1	120	1000 - 3000
E. F. Johnson	250-37 250-38	52	UHF	10:1	1000	3.5 - 150
Knight-Kit	P-2	52 or 72	UHF	20:1	1000	1.8 - 432
Lafayette	TM-28	52 or 72	UHF	20:1	1000	2.0 - 50
Lincoln	L2501	52	UHF	20:1	1000	2.0 - 200
Quement	—	52	UHF	3:1	1000	2.0 - 50
Sierra	164B	50	N, C, UHF	∞:1	5000*	2.0 - 1000

*Depends on plug-in element.

there won't be enough voltage developed across it. However, proper choice of circuit dimensions and component values will permit operation over all of the ham bands up to 50 mc; some specialized units are useable up to 1000 mc.

Of course, the accuracy of this instrument depends quite strongly on the fact that the voltage induced by the transmission line current just precisely cancels out the voltage sample. What this means is that the pickup line has to be adjusted to obtain a good null when the line is properly terminated and there are no reflected components. Another, and perhaps easier way of nulling out the pickup unit is to adjust the value of the terminating resistor[6]; by adjusting this resistor, you can set the voltage drop across it so that it exactly equals the voltage sampled.

Usually two identical pickup units are used, one for forward power, the other for reverse power. However, in some designs, only one pickup is used; it is connected in such a way that it does the work of two. This may sound like you are getting something for nothing, but although the pickup is physically only one piece, electrically it looks like two separate units.

Possibly the biggest source of error in the

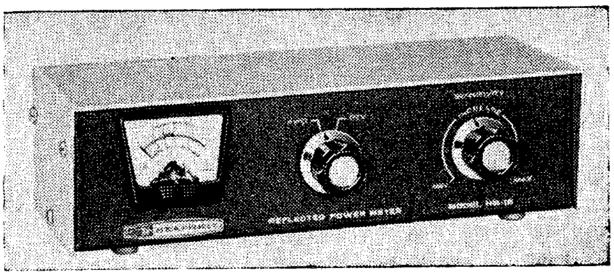


Photo courtesy Heathkit.

The Heathkit reflected power meter provides a reliable method of determining the swr on any 50 or 70 ohm transmission line up to 6 meters. It may be installed permanently in the line and permits continuous monitoring of line operation.

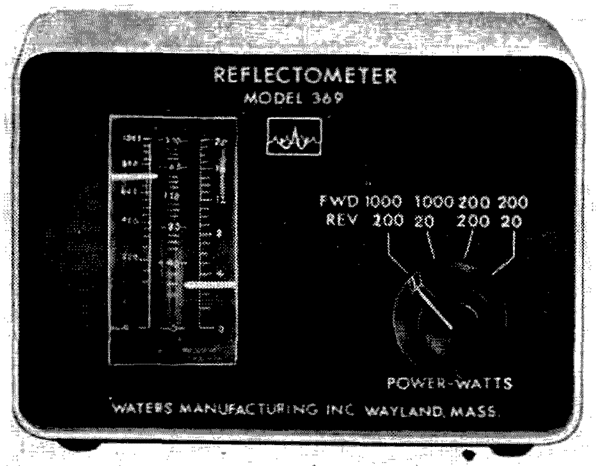


Photo courtesy Waters Manufacturing Inc.

The Waters reflectometer shows both forward and reflected power in 52 ohm transmission lines. In addition, this instrument has multiple scales that provide increased sensitivity for accurate readings of low reverse power values.

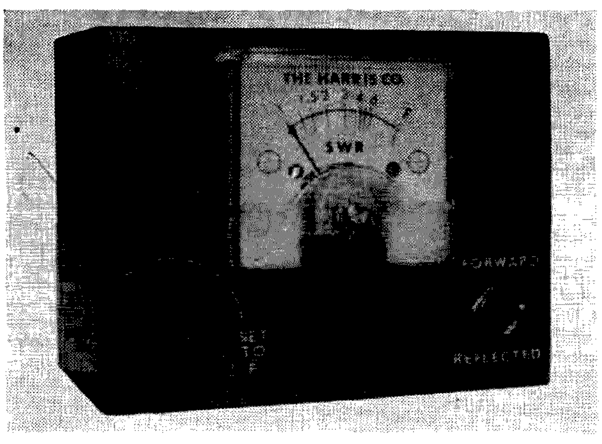
standing wave meter lies in nonlinearity of the semiconductor diodes. For this reason you might find that you don't get the same SWR readings at high power levels as you do at low levels. However, the differences are usually quite insignificant, if even noticeable at all.

Although all of the reflectometer standing wave meters of this type are identical electrically, there are any number of constructional variations. The early units consisted simply of a small loop of wire placed inside a waveguide or between the inner and outer conductors of the coaxial line. This type of construction is a little difficult to duplicate however, and later designs were laid out with the ham in mind. Perhaps the most popular of these is the trough type line with two pickup wires laid out on each side. Later variations of this theme use a piece of enameled copper wire threaded under the outer braid of a piece of RG-8A/U coaxial cable. This latter technique is quite easy to duplicate and has proven to be quite successful on the VHF bands because it preserves the characteristic impedance of the system.

Another method of construction which has been used by some manufacturers and written up in several amateur journals uses an entirely different technique. In this approach, a toroidal current transformer is very closely coupled to the transmission line. In addition, a small amount of voltage is picked off the line with small variable capacitors. This type of construction has the advantage that the current transformer may be electrostatically shielded so that it is only *inductively* coupled to the line. Furthermore, the capacitors can be laid out so that the voltage pickup may be controlled and not effected by stray capacity. In this way an instrument can be constructed which is quite accurate over a broad frequency range, and more important, provides consistent and reliable measurements.

The primary consideration in selecting standing wave meters is the characteristic impedance of the unit and its variations with frequency. The more expensive units exhibit a constant impedance at frequencies in excess of 1000 mc, but many of the inexpensive units exhibit non-constant impedance and may be used in either 50 or 75 ohm lines up to 30 megacycles with almost no detectable difference. In the Heathkit HM-15, different values of load resistors are provided to compensate for differences in 50 and 75 ohm transmission systems.

In addition to standing wave measurements, many of the instruments of this type may be used to accurately measure rf power. In the inexpensive devices, only relative power may be determined.



The Harris Company's standing wave ratio meter. This unit is unique because it uses a printed circuit pickup assembly.

Photo courtesy Allied Radio Corp.

The Knight-Kit swr/power meter is a flexible two-unit instrument that may be used on all the ham bands up to 432 mc. It is suitable for use with either 50 or 70 ohm lines and its negligible insertion loss allows it to be left in the line as a constant monitor.

Coaxial attenuators

The coaxial attenuator or pad is a device that is unfamiliar to many amateurs, but which is very useful in many applications. Basically, the attenuator consists of a resistance network which reduces the rf power between the input and output while maintaining the characteristic impedance of the transmission line. They are categorized by the amount of power loss through them in decibels; a 3 db attenuator for example will reduce the power by approximately one-half.

Accurate rf attenuators may be used in s-meter calibration, checking sideband suppression, and measuring crosstalk, receiver image and *if* signal rejection, relative antenna gain and receiver noise figure. A 20 db attenuator installed at the antenna terminals of a receiver is particularly helpful in reducing cross-modulation and overload when working local stations. Attenuators are also used between SSB exciters and linear amplifiers when the exciter output exceeds the recommended driving power of the amplifier.

The two basic constant impedance attenuating circuits are the "tee" and "pi" illustrated in **Fig. 9.** The names for these circuits were derived from the similarity of the circuits to the letter "T" and the Greek letter "π" respectively.

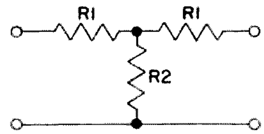
Most commercial attenuators are constructed using disc resistors as shown in **Fig. 9.** This type of resistance element presents a *sheet* of resistance to the circuit and has been used successfully at frequencies in excess of 1000 mc. However, these disc resistors are quite expensive and for amateur applications, composition resistors may be used with no noticeable effect up to about 250 mc. Above 250 mc it is difficult to predict the rf resistance of composition resistors however, and the more sophisticated disc resistors should be used.

Simple 50 ohm tee attenuators may be constructed using composition resistors as shown in **Fig. 9.** The required resistance values for various amounts of attenuation are listed in **Table 4.** These values are based on the use of standard 5% tolerance resistors and are not 100% accurate in terms of attenuation, but are within $\pm 2\%$ of the proper value. For other than 50 ohm systems, the required tee attenuator resistance values may be calculated from the following equations:

$$R_2 = \frac{2Z_0\sqrt{N}}{N-1}$$

$$R_1 = Z_0\left(\frac{N+1}{N-1}\right) - R_2$$

Table 6. 50 ohm T-Pad Attenuator Resistance



db	R1	R2	db	R1	R2
0.1	0.30	4300	4	11	100
0.2	0.56	2200	5	15	91
0.3	0.82	1500	6	16	68
0.4	1.1	1100	7	20	56
0.5	1.5	910	8	22	47
0.6	1.8	750	9	24	39
0.7	2.0	620	10	27	36
0.8	2.4	560	11	27	30
0.9	2.7	470	12	30	27
1.0	3.0	430	13	33	24
1.1	3.3	390	14	33	20
1.2	3.3	360	15	36	18
1.3	3.6	330	16	36	16
1.4	3.9	300	17	39	15
1.5	4.3	300	18	39	13
1.6	4.7	270	19	39	11
1.7	4.7	240	20	39	10
1.8	5.1	240	25	43	5.6
2.0	5.6	220	30	47	3.3
2.2	6.2	200	35	47	1.8
2.5	6.8	180	40	51	1.0
3.0	8.2	150	45	51	0.56
3.5	10.0	120	50	51	0.33

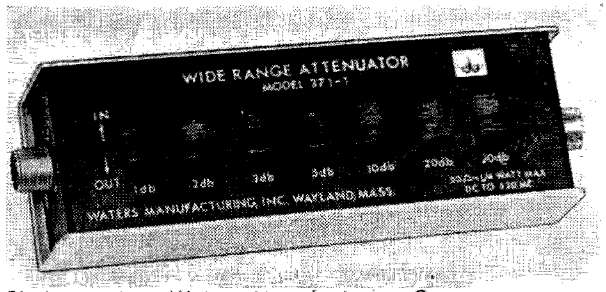


Photo courtesy Waters Manufacturing Co.

This Waters wide range coaxial attenuator provides up to 61 dB attenuation in 1 dB steps. It is accurate within one dB from dc to 225 mc.

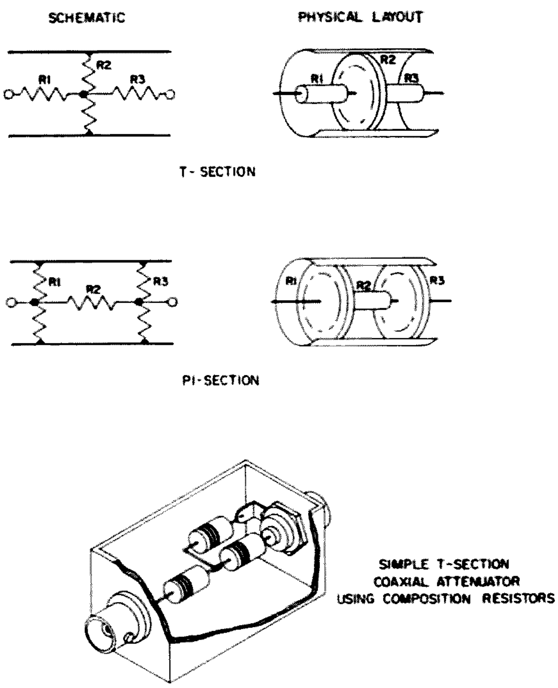


Fig. 9. Circuits and typical layout of attenuators for use in amateur equipment.

Example What resistance values are required for a tee attenuator with a characteristic impedance of 75 ohms and attenuation of 20 db? From a db-power ratio table or from the expression N = antilog (db/10), it is determined that 20 db corresponds to a power ratio of 100. Therefore:

$$R_2 = \frac{2Z_0\sqrt{N}}{N-1} = \frac{2\,(75)\sqrt{100}}{100-1} = 15.2 \text{ ohms}$$

$$R_1 = Z_0\left(\frac{N+1}{N-1}\right) - R_2 = 75\left(\frac{100+1}{100-1}\right) - 15.2$$
$$= 61.3 \text{ ohms}$$

One commercial attenuator that is designed specifically for amateur use is the Waters Model 371 Wide Range Attenuator. This unit is usable from dc to 225 mc and provides up to 61 db attenuation in one db steps.

Baluns

One of the advantages of the coaxial transmission line system is that the rf power is confined within the outer conductor of the cable. This insures that the transmission line doesn't act like an antenna, but transmits the power to the antenna where it is properly radiated; this increases the efficiency of the antenna/transmission line system and greatly reduces TVI and other sources of interference. Unfortunately however, most antennas are balanced devices and for proper operation, they should be fed with a balanced transmission line. In most amateur stations, coaxial feedline is indiscriminately connected to a dipole or multi-element array, both of which are balanced, with little thought to the balance-unbalance mismatch that occurs. The results can often be quite confusing. For instance, it is almost impossible to obtain meaningful standing wave measurements when there is a balance-unbalance mismatch in the system. Furthermore, almost all antennas, and tri-band beams in particular, display very confusing and esotoric resonance curves when fed with this type of a system. In addition, to obtain the desired pattern in high-gain antenna systems, it is imperative that a good balance to ground be preserved. When an inherently balanced antenna is fed with a coaxial feedline, the electrical feed point may be shifted away from the designed point, changing the ohmic value of the load and introducing reactance into the system.

On the other hand, when a balanced load is connected to an unbalanced transmission line, the resultant balance/unbalance mismatch may cause standing waves, cause rf currents to flow on the outside braid of the coaxial line resulting in unwanted radiation, or couple the load reactance back to the transmitter or receiver. The important point here is that this can happen even if the antenna is resistive and matches the impedance of the coaxial line.

The solution to this problem of course lies in the balance-to-unbalance converter or *balun*. There are several different types of baluns, three of which are illustrated in **Fig.**

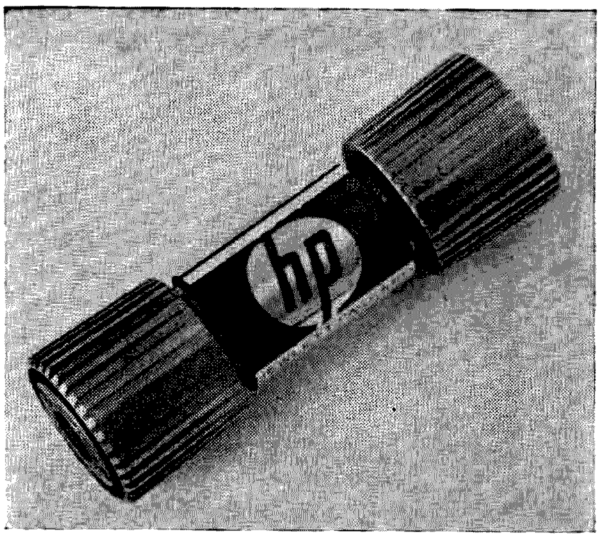


Photo courtesy Hewlett-Packard.
Hewlett-Packard fixed coaxial attenuators are representative of the types of commercial attenuators presently available. These units are available in 3, 6, 10 or 20 db attenuation and are usable from dc to 18,000 mc.

10. The coaxial sleeve balun or *bazooka* is quite popular on the UHF bands and operates on the principle that a shorted quarter-wave line presents a high impedance at the open end. A relatively high impedance exists between the inner and outer conductors of the transmission line and with the addition of the shorted quarter-wave sleeve, a high impedance appears between the outer conductor of the transmission line and the outer shell of the sleeve. In other words, the quarter-wave detuning sleeve has the effect of freeing the outer conductor of the coaxial cable from ground and if the balun is connected to a balanced load, the two output leads will assume equal impedance to ground.

Although the coaxial sleeve balun is primarily a 1:1 impedance converter, the quarter-wave sleeve and coaxial line with which it is used can be designed so that it will serve as an impedance matching transformer or Q section. By using the procedure laid out by K6HCP and WA6GYD,[13] this type of balun may be used for matching 52 ohm coaxial lines to 200, 300 or 450 ohm balanced lines. Although this type of a balance to unbalance converter is not too practical on the high-frequency bands, it has proven very useful on 144, 220 and 432 mc.

The quarter-wave open balun is nothing more than a simple method of making a quarter-wave coaxial detuning sleeve. Although this type of construction is simple and expedient, the results are not as good as those provided by the coaxial sleeve. This is because the open type construction is not as efficient in detuning as the sleeve which completely encircles the coaxial transmission line.

The balun which has been most popular with amateurs is the simple half-wave phase inverter balun shown in **Fig. 10** and **11.** This type of balun is very easy to build, but it suffers from two very serious disadvantages. First of all, it is useable over a narrow band of frequencies; whenever the length of the phasing line deviates very much from the required half-wavelength, it no longer provides the necessary balance to unbalance conversion. This means that a different balun has to be built for each ham band; on the VHF bands the line length is so critical it is nearly impossible to obtain proper operation.

This type of a balun takes advantage of the 180 degree phase inversion which takes place along a half wavelength line. When a negative peak of the sinusoidal rf current appears at A, a positive peak appears at B. Since both of these peaks appear on the center conductor, they exhibit a high impedance to ground and

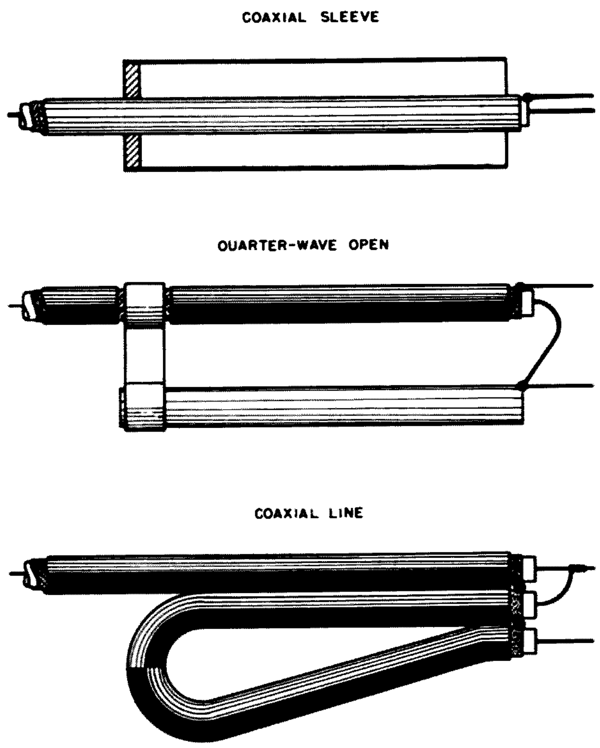


Fig. 10. Various types of balance to unbalance converters or baluns. The coaxial sleeve balun is most satisfactory for the VHF and UHF bands while the other two types find use on the high-frequency bands up to 30 mc.

present a balanced output. The half-wave phase inverter balun gives an impedance ratio of 4:1 because the phase inverter provides a voltage step-up of 2:1.

Each of these three baluns depends upon a

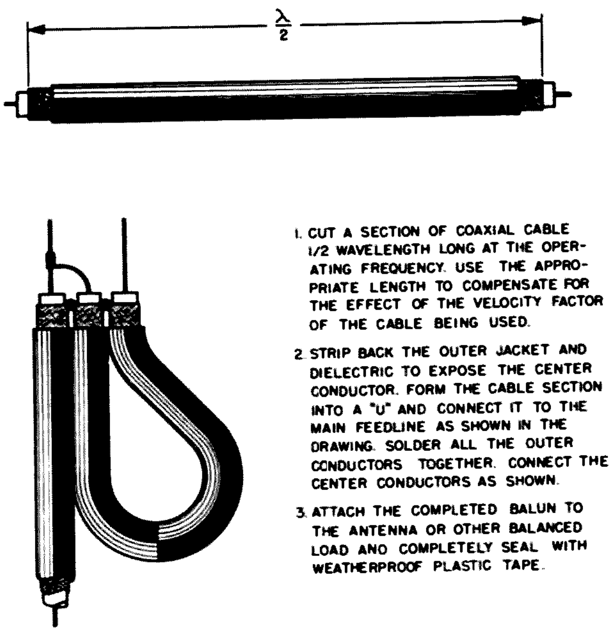
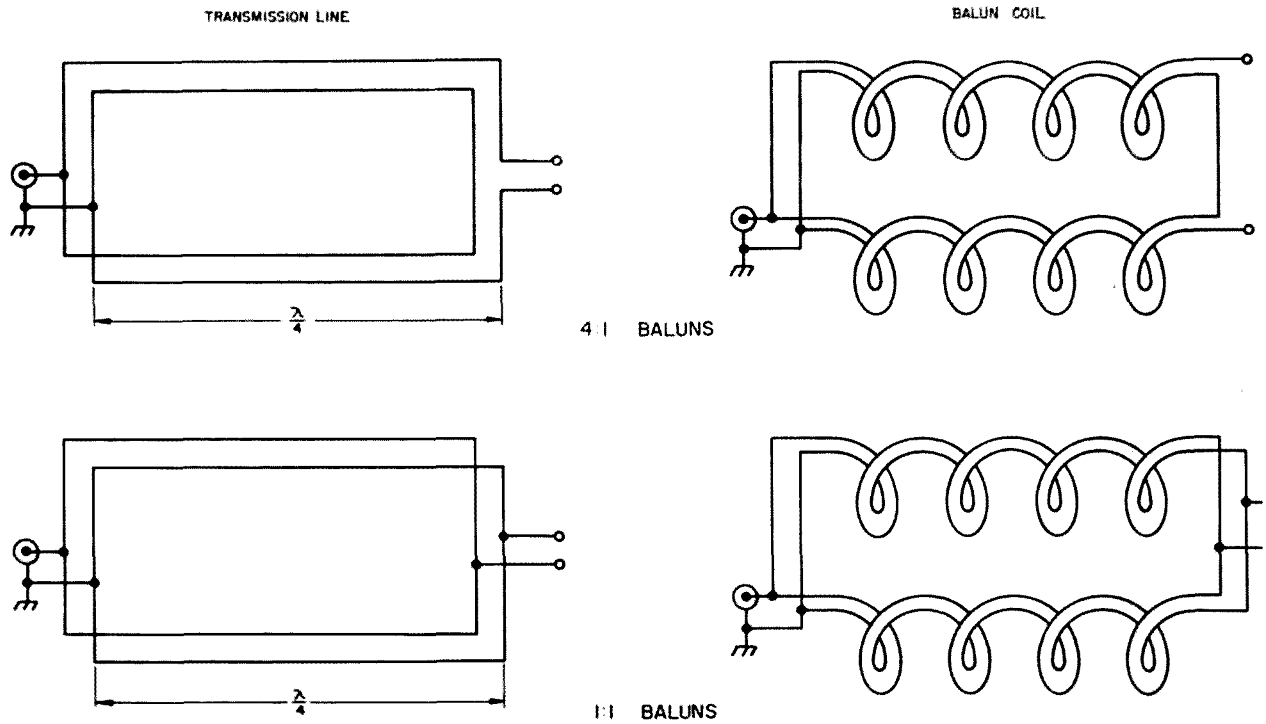


Fig. 11. Construction of the half-wave phase inverter balun. This balun is relatively narrow-banded, but it is easy to build and satisfactory for many applications.



Development of the broadband balun coil from linear transmission line theory.

frequency dependent length of transmission line. This is suitable for single band operation, but for wide bandwidths, another approach must be used. By applying a closely coupled bifilar air-wound transformer, a balun can be made that will work effectively from 3.5 to 30 mc. The air-wound balun is somewhat bulky and limited in power handling ability, but recent advances with ferrites have resulted in small, compact and efficient baluns that will work over extremely wide bandwidths.[8]

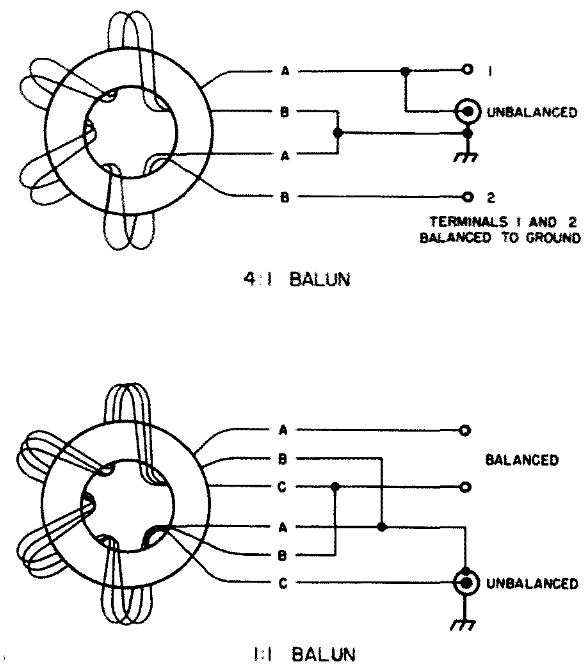


Fig. 12. Method of winding and connecting ferrite cored baluns to obtain either 1:1 or 4:1 impedance ratio. This type of balun may be used over a bandwidth from 3 to 30 mc.

To explain how these balun transformers work, we have to resort back to the transmission line for a moment. If two transmission lines of equal length which have a characteristic impedance (Z_0) of 100 ohms are connected in series at one end and in parallel at the other, at the series connected end the lines are balanced to ground and will match 200 ohms. On the other hand, at the parallel connected end the lines will be matched by an impedance equal to 50 ohms. This shouldn't be hard to understand if we remember for a moment that two resistors in series add while the equivalent resistance of two equal resistors in parallel is one half of the resistance value of the resistors. If the length of the series/parallel connected transmission lines is an odd multiple of one-quarter wavelength, one side of the parallel connected end may be grounded and the balanced end (series connected) will be effectively decoupled from it. Since the input impedance of this balun is 50 ohms and the output is 200 ohms, it exhibits an impedance transformation ratio of 4:1.

To obtain an impedance transformation ratio of 1:1 with this type of balun, the lines are connected in parallel at both ends. As previously, one side of either parallel con-

Table 5. Baluns

Manufacturer	Model Number	Unbalanced Impedance (ohms)	Frequency Range (mc)	Power (watts)	Impedance Ratio	Connector
Ami-Tron	Kit	50 or 75	1.0 - 60	1000	1:1, 4:1, 9:1	None
B&W	725	75	1.5 - 30	2000	4:1	UHF
B&W	3975	75	3.5 - 30	250	1:1 or 4:1	UHF
Fugle	—	50 or 75	3.0 - 30	1000	1:1 or 4:1	None
Millen	46672	50 or 75	3.5 - 30*	—	4:1	UHF
Telrex	1K81B	52	3.5 - 30	500	1:1**	None
Telrex	2K81B	52	3.5 - 30	1000	1:1**	None
Telrex	4K81B	52	3.5 - 30	2000	1:1**	None
Telrex	2K816B	52	1.7 - 14	1000	1:1**	None
Translab	601	50 or 75	2.0 - 30	1000	1:1	N
Translab	601A	50 or 75	2.0 - 30	1000	4:1	N
W2AU	—	50 or 75	3.0 - 30	1000	1:1 or 4:1	UHF

*Five models required to cover this range.
**Available in 4:1 impedance ratio at slightly higher cost.

nected end may be grounded, and the other end may be connected to a balanced load and be effectively decoupled from the grounded end.

Although this discussion has assumed the use of regular transmission lines, the two lines can be wound into a coil, either air-wound or ferrite cored. The inductances formed by these windings act as chokes and tend to further isolate the balanced end from the grounded end. In fact, the frequency range of this type of balun is greatly extended because of the greater isolation obtained through choke action. At the high frequency end of their range, these transformers act like transmission lines, and at the low frequency end, like very closely coupled coils.

The majority of the commercial baluns come completely assembled and ready to install, but one company, Ami-Tron Associates, provides a ferrite core and a length of number 14 wire so you can wind your own. To make a 1:1 impedance ratio balun, you wind ten trifilar turns on the core and connect it as shown in Fig. 12A; for a 4:1 impedance balun, wind ten

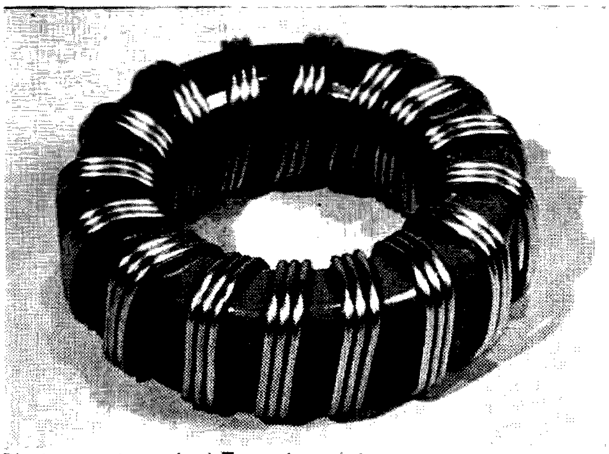


Photo courtesy Ami-Tron Associates.

The Ami-Tron Associates toroidal balun is furnished as a kit which may be easily made into a wide band balun. By simply changing the number of turns of wire and their connections, this kit will make either a 1:1, a 4:1 or a 9:1 balun that is usable from 160 meters to 60 mc.

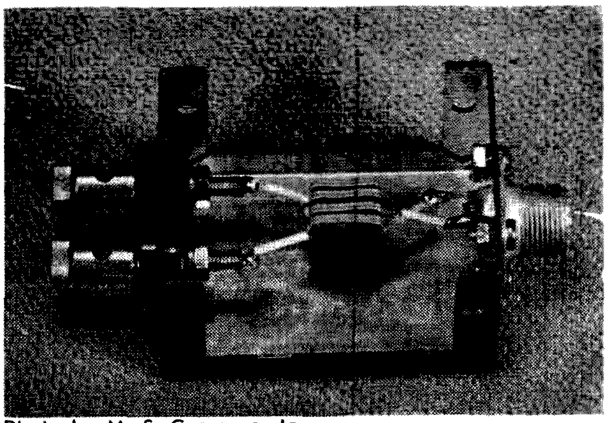


Photo by M. S. Gassman, Jr.

A VHF balun using a commercially available TV receiver antenna transformer. This balun may be used in the frequency range from 20 to 150 mc with up to 20 watts; over 20 watts of power results in excessive heating.

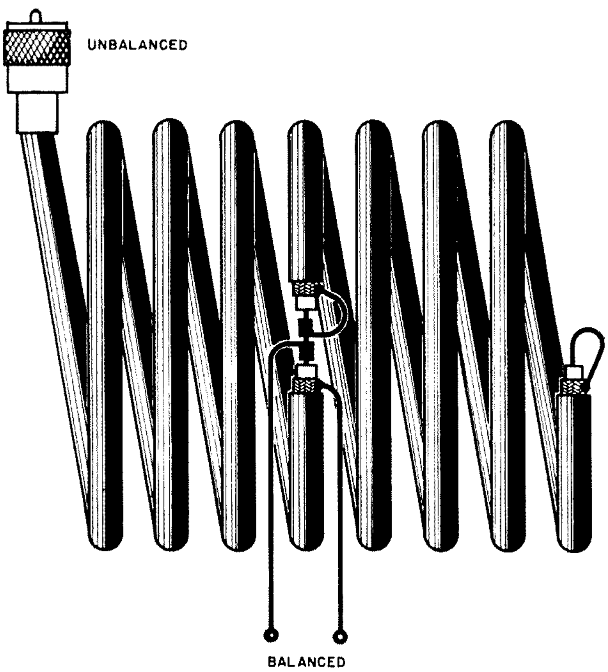


Fig. 13. A broad band coaxial balun using a length of coaxial cable. This balun may be used over all the ham bands below 30 mc with excellent results.

bifilar turns on the core and connect it as shown in **Fig. 12B**. Both of these baluns may be used over the frequency range from 3.5 to 54 mc and will handle a full kilowatt of rf.

Although the ferrite core balun is extremely compact, it is somewhat expensive, and a very reasonable way of obtaining the same electrical characteristics was described by K2HLT some time ago.[7] In his approach approximately 30 feet of RG-59/U is wound into a coil as shown in **Fig. 13.** The coil is center-tapped and the balanced output taken from the inner and outer conductors as shown in the drawing. The inner and outer conductors are shorted together on the lower part of the coaxial cable coil while the unbalanced input is at the top. Actually this balun represents a simple autotransformer, tuned to resonance at approximately 14 mc by the distributed capacity of the coaxial cable on the top half of the coil. Because the Q of the cable is in the vicinity of 200, there are very low losses associated with this type of construction. However, when the balun is loaded with a 75 ohm load, the selectivity of the circuit is broadened out to encompass a 30 mc bandpass.

The transmitter signal is coupled by the coaxial cable in the upper half of the coil to the bottom half, which is simply a coil to ground. However, the bottom coil is inductively coupled to the top coil with essentially unity coupling. Since each coil feeds one side of the balanced output and each side has equal inductance, the output is balanced.

Measurements made by K2HLT on this 72 ohm 1:1 balun indicate that over the bandpass of 1.6 to 30 mc, it has less than 0.5 db attenuation, less than 0.5 db of unbalance and a standing wave ratio less than 1.2:1. Although this balun uses the small diameter RG-59/U, larger coaxial cables may be used in a balun of this type. W6SAI has described a broadband 52 ohm balun using essentially the same technique but employing 52 ohm RG-8A/U cable.[9] This balun had an over-all passband from 6 to 32 mc and would handle a full kilowatt. Since the operation of this device is limited at the low frequency end by the inductance of the windings, the use of a longer length of cable should result in lower useable operating frequencies. The coil must be redesigned for the differences of each cable, but the required procedure is quite simple. All you have to do is adjust the length and size of the coil to resonate at approxi-

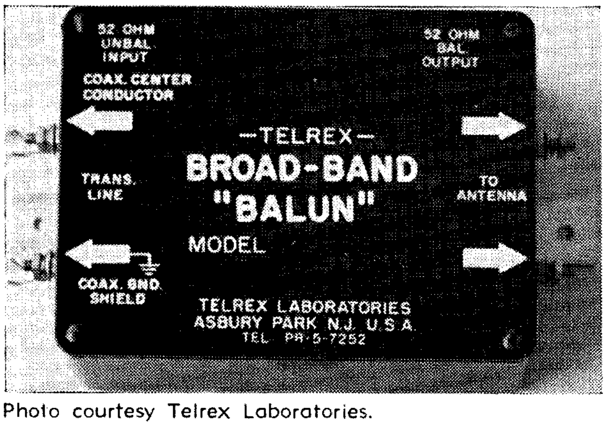


Photo courtesy Telrex Laboratories.

The Telrex broad-band baluns are available in several models that will handle up to 4 kilowatts PEP. These baluns may be mounted at the antenna feedpoint and provide a convenient and efficient method of feeding balanced antennas with coaxial transmission line.

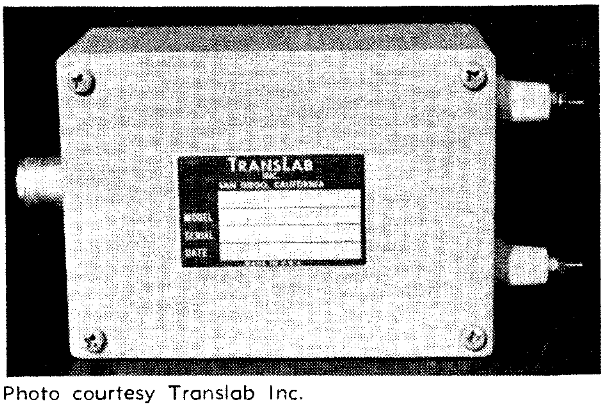


Photo courtesy Translab Inc.

Translab's broadband ferrite balun is a completely weatherproof unit which provides a balanced output from 50 or 70 ohm coaxial lines over a frequency range from 2 to 30 mc. It will handle 2 kilowatts PEP and is available with either a 1:1 or 4:1 impedance ratio.

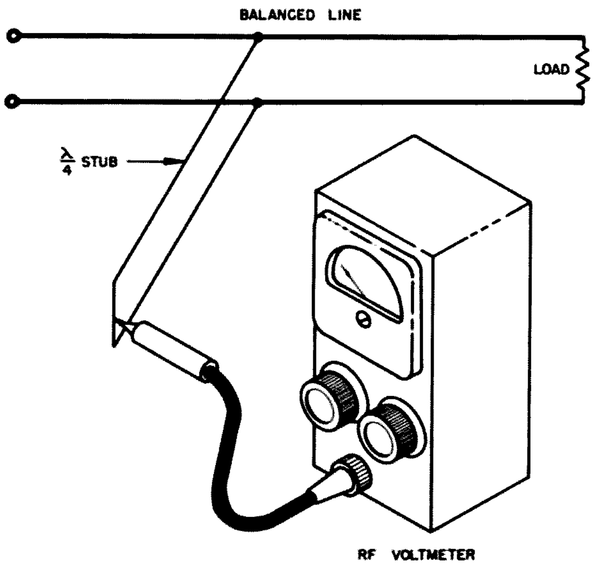


Fig. 14. Measuring the balance of the balance to unbalance converter. If the balun is providing an exactly balanced output, there will be no indication on the voltmeter.

mately 14 mc while retaining the required bandwidth under load conditions.

The chief item of concern in the performance of a balun is the amount of balance that exists on the balanced output line. This may be determined by measuring the voltages from each of the balanced conductors to ground. Many high-frequency VTVM's are suitable for this purpose, but the input impedance of the VTVM must be very high so that it will not introduce any unbalance of its own.

Since the voltmeter only gives a reading proportional to amplitude, this method will not detect unbalance in which the peak amplitudes of the voltages on the two lines are equal but do not occur 180 degrees apart in time. A better method of detecting this *phase* unbalance is illustrated in **Fig. 14.** Since

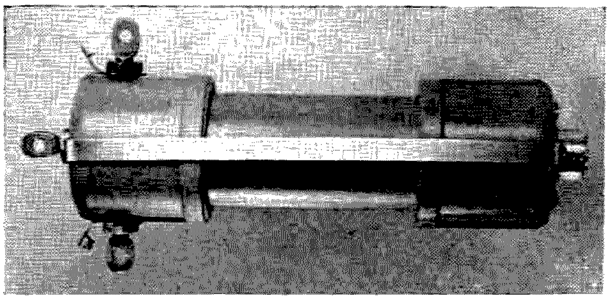


Photo courtesy Unadilla Radiation Products.

The W2AU balun is a wideband unit available in either 1:1 or 4:1 impedance ratios. It can serve as the center insulator in a dipole or inverted vee antenna and has a built in hang-up hook and lightning arrester. This balun may be used from 3 to 30 mc with 50 or 70 ohm coaxial transmission lines and will handle over 2 kilowatts PEP.

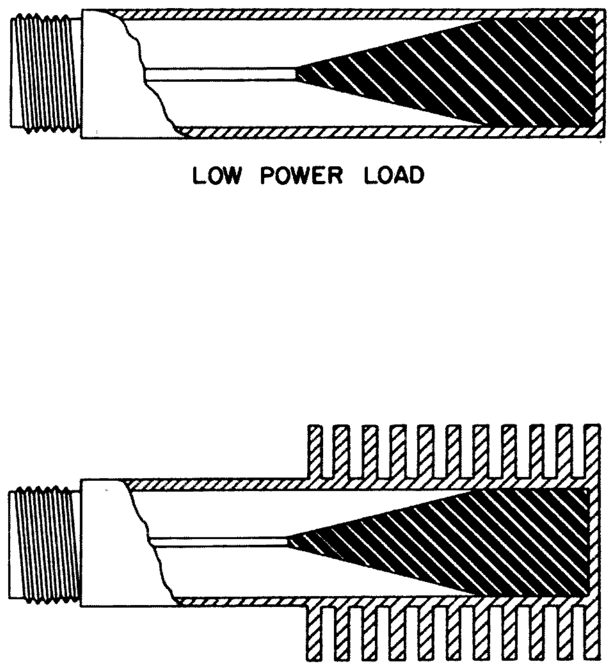


Fig. 15. Construction of broad band coaxial dummy loads. The tapered resistance element of these loads insures that they will provide a matched load up to several thousand megacycles.

the stub is short-circuited, it will present an infinite impedance to the balanced voltage. For unbalance voltages, however, the quarter-wave stub is open-circuited at its end so that the points on the dual line at which the stub is attached are short-circuited for unbalanced currents. Therefore, there will be some voltage from the end of the stub to ground if any unbalance exists on the line.

Dummy loads

The dummy load is an indispensible coaxial accessory which is used primarily for tuning transmitters. However, an accurate dummy load is also useful for calibrating SWR meters and measuring rf power. Although the common household light bulb is sometimes used as a load, it is not too suitable because it does not present a constant load to the transmitter. This is because as the light bulb heats up (becomes brighter), the rf impedance of the filament increases.

Commercial dummy loads suitable for use from dc to microwave are constructed as shown in **Fig. 15.** Here the resistance element consists of a conical block of resistive material mounted in the end of a metal tube. The tapered section from the center to outer conductor is used to provide a good impedance match over a broad range of frequencies. For

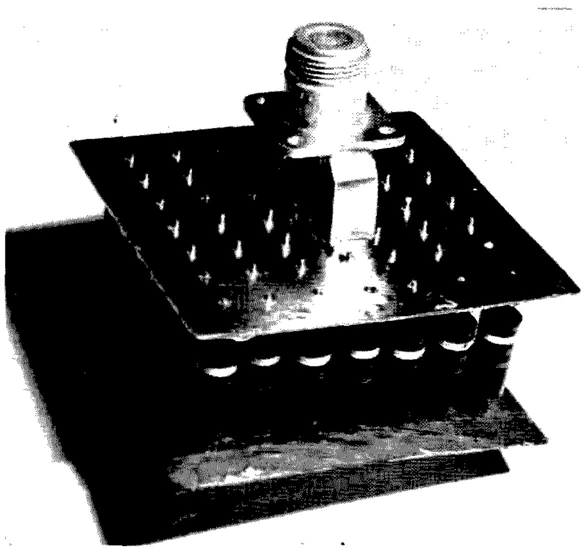


Photo by WA6IAK.

A homemade 100 watt dummy load that is suitable for use to 200 mc. This load is made by installing ordinary two watt carbon resistors between two copper plates.

higher power applications, the metal case may be provided with cooling fins or immersed in a bath of transformer oil.

For frequencies up to about 200 mc, a suitable load may be made by mounting a number of common composition resistors in parallel. In the homemade unit pictured, forty-eight 2400 ohm, 2 watt resistors are mounted between two copper sheets 2 inches square. This load will dissipate 50 watts continuously and up to 200 watts for short periods; the power capacity may be increased by simply immersing the load in a can of ordinary motor oil.

For higher power capacity, a non-inductive carborundum resistor may be used as a dummy load. The Heathkit HN-31 "Cantenna" uses this type of construction to provide a dummy load that will dissipate up to 1000 watts ICAS (intermittent commercial or amateur service) and provide an SWR of less than 2:1 all the way up to 400 mc. The Cantenna has a continuous power rating of 200 watts, but when cooled with transformer oil, it will dissipate 1000 watts for periods up to 10 minutes. Actually, up to about 50 mc this dummy load exhibits an essentially resistive characteristic; above 50 mc it begins to show a small amount of reactance that causes the standing wave ratio to be greater than unity. The overall effect is not too severe on 50 mc, but at 432 mc an SWR of 2:1 can raise havoc with power and SWR measurements. K6MIO has shown[12] that the Cantenna is slightly inductive at 432; by placing a small variable shunt capacitor across the load, this inductive reactance can be nulled out. Installation of a variable 20 pf capacitor will allow the Cantenna to be tuned for minimum SWR over the entire VHF range. Furthermore, tests have shown that this capacitor has almost no effect on the operation of the load below 30 mc.

The Gentec dummy loads are hermetically sealed, nonreactive loads with a nominal impedance of 50 or 70 ohms, depending on the model. The excellent rf characteristics of these loads are a result of the film-type resistors which are mounted in a coaxial cavity inside the can. Radiation fins and ribbed surfaces permit good heat radiation. The model 525 (50 ohm) and 725 (70 ohm) loads will dissipate 125 watts continuous and 250 watts ICAS. For higher power applications, the model 510 will handle 500 watts continuous or 1000 watts ICAS. The model 525 and 725

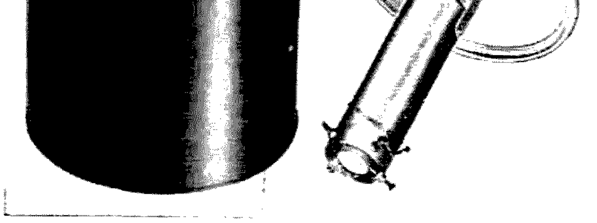
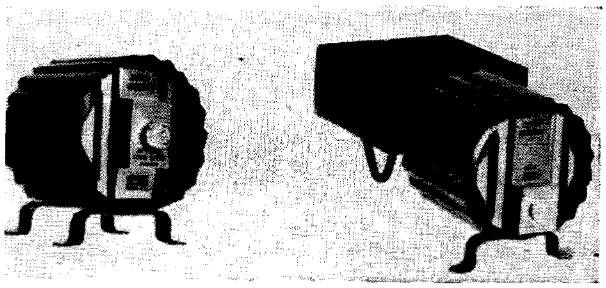


Photo courtesy Heathkit.

The Heathkit "Cantenna" is a dummy load which will dissipate up to a kilowatt for short periods of time. An rf sampling probe is mounted on the top of the container for measuring power output.

Photo by WA6CQL.

Installation of a 15 pf variable trimmer in the Heathkit HN-31 "Cantenna." This capacitor cancels the slight amount of inductive reactance that is present in the range from 220 to 450 mc so that the "Cantenna" presents an essentially resistive 50 ohm load at 432 mc.



'hoto courtesy Gentec, Inc.

The Gentec dummy antennas are hermetically sealed nonreactive loads designed for use from dc to 250 mc. The Model 525 on the left will dissipate 250 watts ICAS; the higher power Model 510U on the right will handle 1000 watts ICAS.

oads are furnished with type UHF connectors, but the model 510 is available with either UHF, N, or BNC fittings. For low power applications, the Gentec model 507 (50 ohms) and 707 (70 ohms) exhibit an SWR of less than 1.05:1 from dc to over 250 mc and have a continuous power rating of seven watts.

The Radiation Devices Company's coaxial terminations are typical of commercial dummy loads designed to work well into the microwave region. These loads have an SWR of less than 1.05:1 from dc up to 1300 mc and less than 1.15:1 up to 4000 mc. These precision loads are constructed around special microwave film resistors which are carefully mounted in machined assemblies. These loads are available in a low power model (LP-1 series) which has the characteristics noted above, and a higher power version, the MP-1 series, which will dissipate up to 12 watts; 25 watts dissipation may be obtained by mounting the MP-1 series load on a suitable heat sink. The MP-1 series exhibits a maximum SWR of 1.1:1 from dc to 1300 mc and 1.2:1 maximum up to 2000 mc.

Another type of dummy load that has proven to be particularly useful, especially for high power above 300 mc, is the lossy coaxial cable load. In this type of a load, a long length of coaxial line is terminated with a low-wattage, non-inductive 50 or 70 ohm resistor. The length of the line is chosen so that the loss at the frequency of operation is such that only a small portion of the incident power reaches the resistor termination. The loss of RG-8A/U at 432 mc for example is pretty close to 5 db per 100 feet; 600 feet of RG-8A/U then has a total loss of 30 db. This means that if 1000 watts of power is pumped into the input end of the cable, only one watt will be dissipated by the small terminating resistor at the opposite end. The beauty of this type of load is that it is almost purely resistive and exhibits a low SWR up to several thousand megacycles. However, before constructing a load of this type, consult the coaxial cable power charts to determine the maximum amount of power the cable can handle at the desired operating frequency.

If the impedance of the load is properly matched to the transmission line, the rf power being dissipated in the load may be determined by measuring the rf voltage across the load and using the relationship:

$$P = E^2/Z$$

Where: P = Rf power in watts
E = Rf voltage across the matched load (RMS)
Z = Rf impedance of the load in ohms

Example If the rf voltage across a 50 ohm load is 75 volts, what is the rf power?
$P = E^2/Z = (75)^2/50 = 5625/50 = 112.5$ watts

The Waters model 334 Dummy Load/Wattmeter was designed specifically for amateurs and combines a non-inductive, oil cooled load with an integral direct reading rf wattmeter. This instrument may be used to accurately measure rf power up to 1000 watts from 2 to 230 mc.

A more accurate method of measuring power that requires a little more equipment is the standard *calorimetric* technique.[14] In this method of measurement, the dummy load is cooled by the flow of coolant over it. The average power dissipated by the load can then

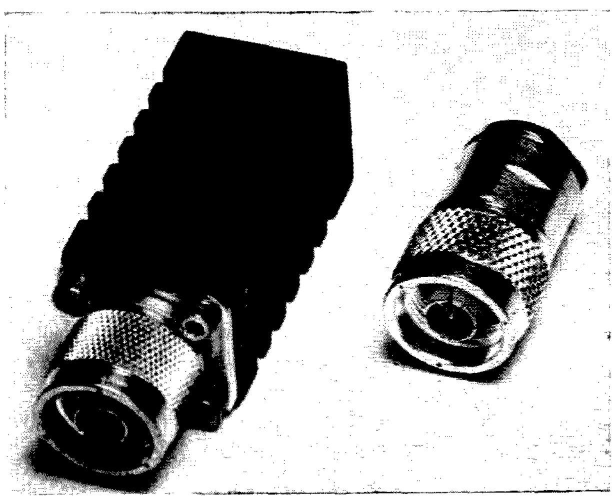


Photo courtesy Radiation Devices Co.

Radiation Devices' precision coaxial terminations. The model on the left will dissipate 12 watts while providing a matched load up to 2000 mc; the dissipation may be increased to 25 watts by mounting the load on a larger heat sink. The load on the right provides a matched load up to 4000 mc and will dissipate one watt.

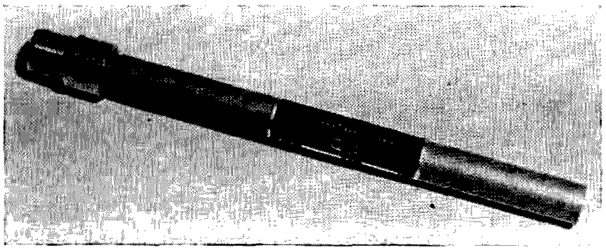


Photo by WA6IAK.

This commercial dummy load for 50 ohm lines provides a matched load up to 12,000 mc.

be determined by measuring the rate of flow and temperature rise of the coolant and using the following formula:

$$P = 264\ Q\ g\ S\ (T_o - T_i)$$

Where: P = Average power dissipated in watts
Q = Rate of coolant flow in US gallons per minute
g = Specific gravity of the coolant
S = Specific heat of the coolant
T_o = Outlet temperature of the coolant °C
T_i = Inlet temperature of the coolant °C

If distilled water is used as the coolant, this formula reduces to the following:

$$P = 264\ Q\ (T_o - T_i)$$

The accuracy of this technique is highly dependent upon the accuracy of the rate-of-flow and temperature measurements, but with the proper instruments, this is not too difficult to obtain. One other important point when using this method is to insure that the heat loss between the input and output measurement points is absolutely negligible; otherwise, erroneous power measurements will result. Also, sufficient stabilizing time must be allowed before the temperature measurements are made because the thermal time constant of this type of equipment is quite long.

Example A dummy load is immersed in a container of distilled water which is being pumped by the load at the rate of 0.5 gallons per minute. If the inlet temperature of the water is 22°C and the outlet temperature is 28°C, what is the average power being dissipated by the load?

$$\begin{aligned} P &= 264\ Q\ (T_o - T_i) \\ &= 264\ (0.5)\ (28 - 22) \\ &= (132)\ (6) \\ &= 792 \text{ watts} \end{aligned}$$

Transmission line filters

A *low pass* filter is placed between the transmitter and antenna to prevent harmonics of the transmitter from interfering with television reception. After the transmitter has been completely shielded and all the power leads bypassed, the only way that interfering harmonic energy can be radiated is through the antenna. By placing a low pass filter in the transmission line, this type of interfering signal may be effectively controlled. For transmitters operating on the ham bands up to 30 mc, a low pass filter is usually designed so that it has a cutoff frequency of approximately 45 mc. With this type of cutoff, maximum attenuation occurs in the middle of channel 2 and TVI is minimized.

For the operator who is interested in operating on six meters, the problem is somewhat more complex. Since the six meter amateur band is immediately adjacent to television's channel 2, it is difficult to design a filter that is effective in eliminating radiation only two megacycles away. Unfortunately, filters are just not that good. However, by limiting six meter operation to the first one megacycle of the

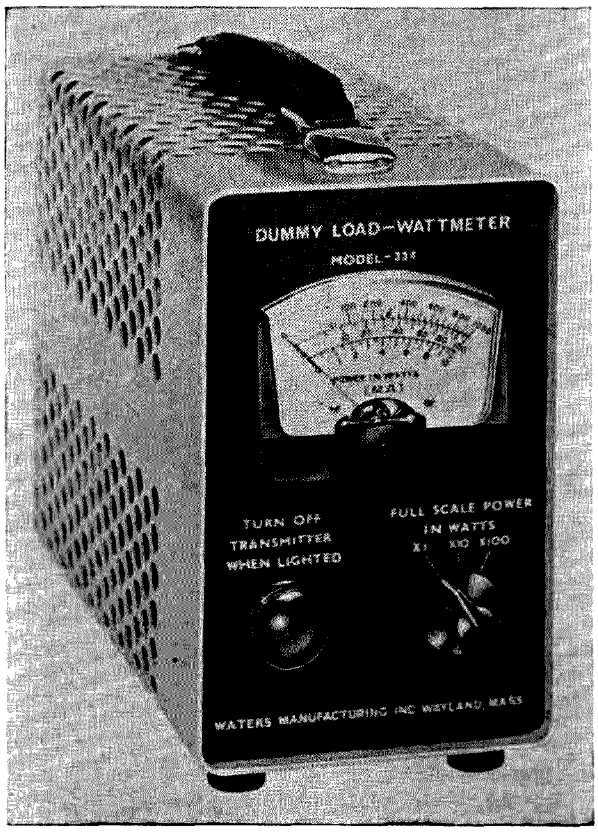


Photo courtesy Waters Manufacturing Co.

The Waters dummy load—wattmeter is an rf power absorption device with an integral direct reading rf wattmeter. It is rated at 50 watts continuous duty or 1000 watts intermittent over a frequency range of 2 to 230 mc.

Table 4. Low pass filters

Manufacturer	Model Number	Impedance (ohms)	Attenuation	Maximum Power (watts)	Cutoff Freq. (mc)	Connectors
Ameco	LN-2	52	35 db above 50 mc	200	40	UHF
Bud	LF-601	52 or 72	85 db above 54 mc	1000	42	UHF
B&W	423	52 or 75	50 db above 62 mc	100	54	UHF
B&W	424	52 or 75	50 db above 54 mc	100	40	UHF
B&W	425	52	85 db above 54 mc	1000	40	UHF
B&W	426	75	85 db above 54 mc	1000	40	UHF
B&W	427	52 or 72	60 db above 62 mc	1000	54	UHF
Clegg	372	52	40 db above 68 mc	240	54	UHF
R. L. Drake	TV-1000-LP	52	60 db above 57 mc	1000	52	UHF
R. L. Drake	TV-100-LP	52	60 db above 57 mc	100	52	—
R. L. Drake	TV-CB-LP	52	60 db above 50 mc	100	43	UHF
E. F. Johnson	250-20	52	75 db above 54 mc	1000	45	UHF
E. F. Johnson	250-35	72	75 db above 54 mc	1000	45	UHF

band, it is possible to employ filters that have a cutoff frequency at 53 mc. These filters don't have as much attenuation on channel 2 as do those with a cutoff frequency of 45 mc, but they will eliminate many cases of television interference. However, since the cutoff frequency is so close to the operating frequency, effective low pass filters for six meters will not handle a full kilowatt with realistically sized components; most are limited to approximately 200 watts.

Although low pass filters are by far the most common transmission line filters used in amateur stations, *band pass* filters are very useful in many applications. When operating on VHF and UHF bands, in many cases there are interfering signals from FM stations, television stations and radar installations which are using assigned channels very close to the amateur frequencies. In some cases these interfering signals completely obliterate signals on the amateur bands. By installing a band pass filter in the feed line, this type of interference may be minimized. Other places where band pass filters are helpful are in local oscillator chains for 432 and 1296 mc converters and

Photo courtesy Squires-Sanders Inc.

Clegg Laboratories low pass filter for 52 ohm lines provides more than 28 db rejection from 55 to 68 mc; more than 40 db rejection on any TV channel above 68 mc. A built in notch filter may be adjusted to provide up to 35 db rejection from 55 to 68 mc.

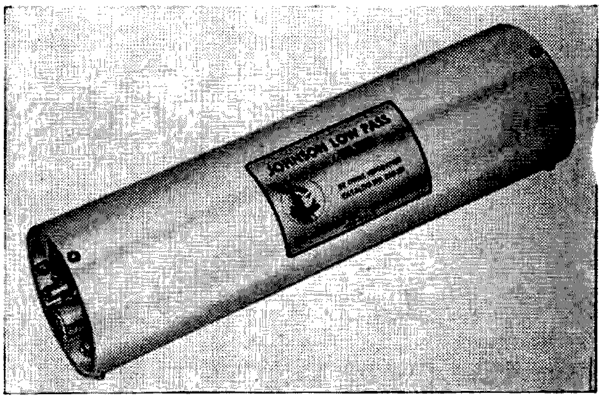


Photo courtesy E. F. Johnson Co.

E. F. Johnson's low pass filter exhibits a cutoff frequency of 45 mc and provides maximum attenuation at 57 mc, the center of TV channel 2. This filter will handle a full 1000 watts of AM or 5000 watts peak SSB.

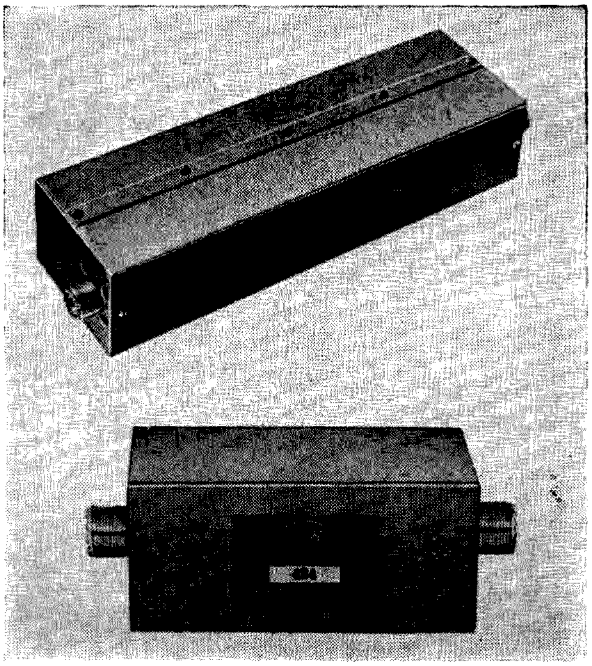


Photo courtesy Barker & Williamson, Inc.

These B&W low pass filters prevent the radiation of spurious and harmonic rf energy which causes TVI. The Model 425 on the left will handle the legal limit while the Model 424 in the foreground is limited to 100 watts.

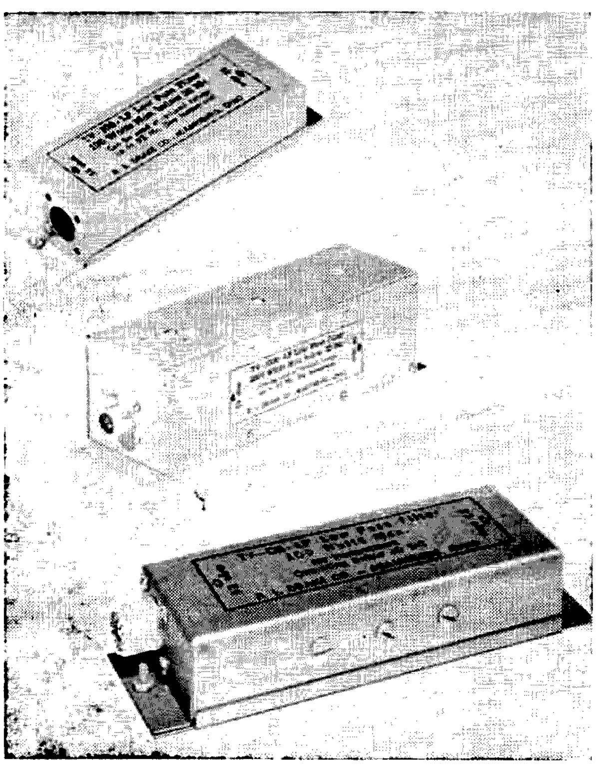


Photo courtesy R. L. Drake Co.

These R. L. Drake low pass filters are designed to prevent TVI from amateur transmitters operating up through 6 meters. The TV-1000-LP filter in the center will safely handle a full kW on the bands up to 10 meters and 200 watts on 6 meters. The smaller TV-100-LP is capable of 100 watts below 30 mc and 20 watts on 6 meters.

when tripling from 144 to 432 mc or from 432 to 1296 mc. In these cases the band pass filter will eliminate birdies in the receiver and/or undesirable out-of-band radiation.

A properly designed filter will introduce very little loss into the transmission system, typically 0.5 db or less. However, to obtain proper filtering, it is imperative that the filter operate into a matched transmission line. If the SWR on the transmission line is greater than about 2:1, the filter will not operate properly and the insertion loss will rise astronomically. Also, if there is a high SWR on the line, irreparable damage may occur to the filter because of the higher effective voltages and currents associated with the high SWR.

Antenna tuners

Antenna tuners are often included in an antenna/transmission line system so that the transmitter and receiver will look into the proper load. However, it should be emphasized that the installation of an antenna tuner is not a cure-all for high standing wave ratios and mismatched antennas; all the antenna tuner can do is provide the transmitter with the load that it was originally designed for. In this respect it will lower the SWR that the transmitter must work into. However, only changing the antenna matching system or the transmission line or both will lower any standing waves that may be residing between the antenna tuner and the antenna.

The addition of an antenna tuner in the line is particularly advantageous when it is desirable to use a low pass filter with a high SWR on the antenna feed line. As has been

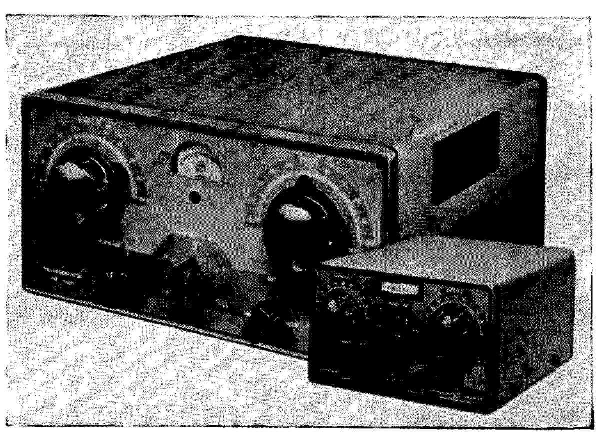


Photo courtesy James Millen Mfg. Co.

The Millen Company's Transmatches are designed to provide a match from the 50 to 70 ohm output of a transmitter to unbalanced loads from 10 to 500 ohms. The Transmatch on the left will handle 2kW peak, while the Transmatch Junior on the right will handle 300 watts peak. Both of these units have a built in reflectometer for measuring swr.

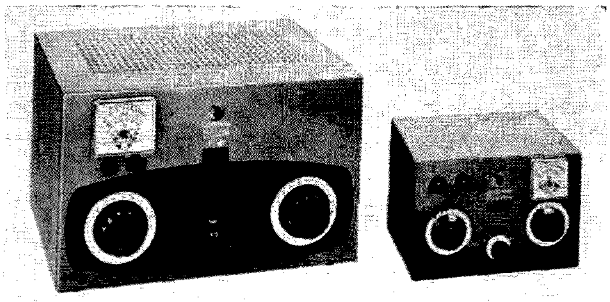


Photo courtesy E. F. Johnson Co.

The Johnson "Matchboxes" are designed to match 52 ohm coaxial line to both balanced and unbalanced reactive and non-reactive loads. These units will operate throughout the 3.5 to 30 mc amateur bands and are available with built-in swr indicators. The kilowatt "Matchbox" on the left will take the legal limit while the smaller unit on the right is limited to 275 watts.

previously noted, the filter must be properly terminated if it is to work properly. If the filter is installed between the transmitter and the antenna tuner, and the tuner is properly adjusted, the filter will be properly terminated and will exhibit the proper cutoff and insertion loss characteristics. Often the inclusion of an antenna tuner in the system is helpful in the reduction of harmonics. This is because the natural Q of the tuned circuits used in the tuner inherently discriminate against frequencies other than those to which they are tuned.

The James Millen "Transmatch" is designed to convert the impedance of any 15 to 500 ohm unbalanced coaxial fed antenna system to 50 ohms so that the transmitter will load properly. Actually, on the lower bands the impedance range of the Transmatch is higher, going up to 4000 ohms, but on ten meters it is somewhat lower. This is because the reactance of the components used in the tuner change with frequency.

There are two models of the Transmatch available, the regular model which is capable of handling the full legal limit and the Transmatch Junior, which is limited to 300 watts peak. A reflectometer is built into each of these units as a constant monitor of line SWR and as an aid in tuning them on each of the bands.

The E. F. Johnson "Matchbox" is an antenna matching and switching system which is designed to match 50 ohm coaxial lines to reactive or nonreactive loads, either balanced or unbalanced. The Matchbox is also designed to provide a separate matching network for the station receiver. A built-in antenna changeover relay is included and it has a provision for muting the receiver when transmitting. The Kilowatt Matchbox antenna changeover system includes a time delay circuit for the relay, providing fast make-slow break action that

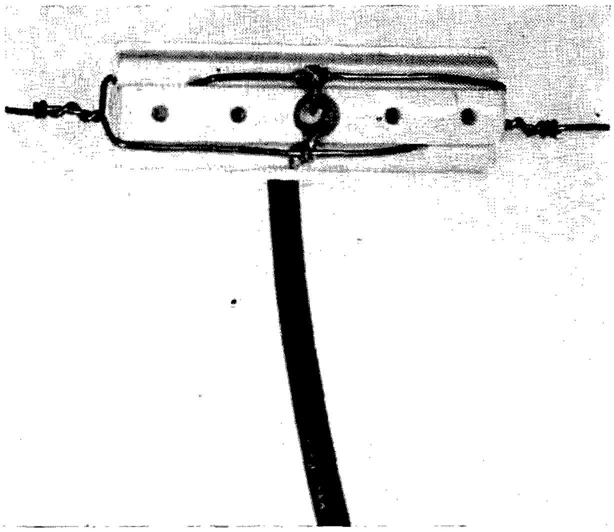


Photo courtesy Yatter Laboratories.

A Yatter Laboratories solid porcelain strain insulator provides a neat and economical method of feeding a dipole antenna with coaxial line. This strain insulator has provisions for mounting a 1:1 coaxial balun, loading coils or even open wire line. When assembled according to the manufacturer's instructions, the completed unit is permanently weather proof and cannot be pulled apart.

prevents arcing or sticking of the relay contacts. This also protects the receiver from high voltage transients which might occur during the antenna changeover from the transmitter. A self-contained directional coupler provides a constant monitor of line operation.

The 275 watt Matchbox is a smaller version

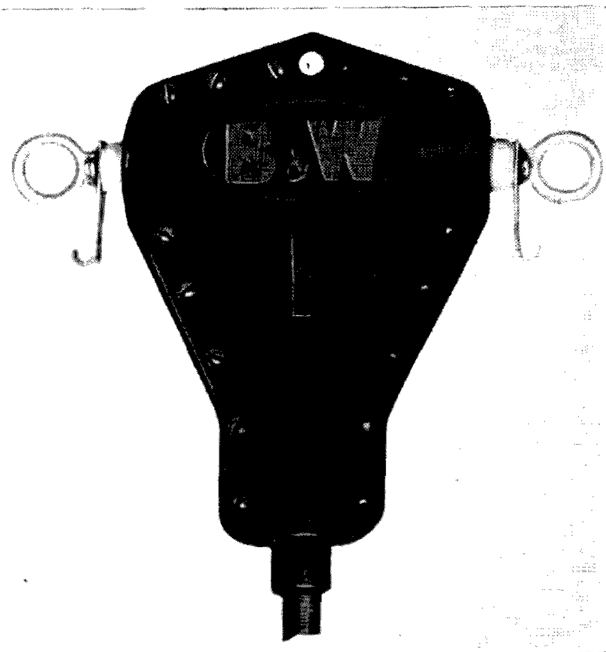


Photo courtesy Barker & Williamson, Inc.

This B&W coaxial cable connector provides a strong, weatherproof connection between the coaxial feed line and the center of a dipole antenna.

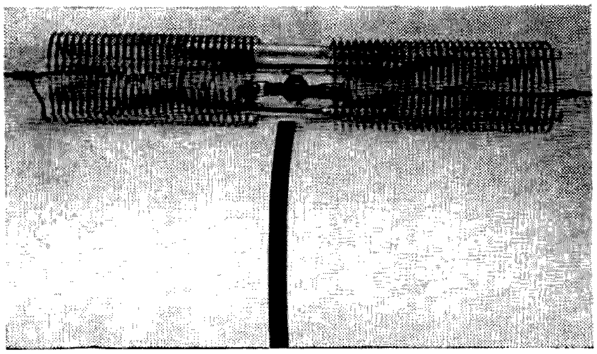


Photo courtesy Yatter Laboratories.
A Yatters Laboratories strain insulator, showing the installation of loading coils and coaxial feed-line.

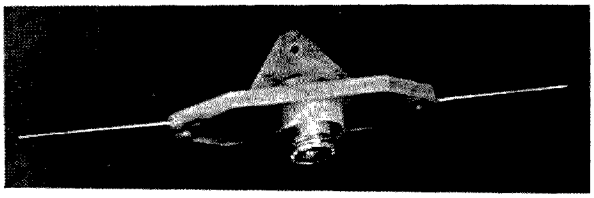


Photo courtesy Budwig Manufacturing Co.
The Budwig antenna-coax connector. This molded unit features holes at both ends for element tie points and has molded-in copper leads for connection to the UHF coaxial connector.

of the kilowatt unit for lower power applications where the high power capabilities of the larger unit are not required. The small unit is almost identical to the larger unit except that it is available with or without the directional coupler.

The World Radio Laboratories MM-100 "Mini-Matcher" is designed to match the low impedance output of an amateur transmitter to a high impedance antenna. This is particularly useful when using an end fed antenna; in many cases the installation of an end fed antenna is more practical than the common center fed doublet. The Mini-Matcher may be used with transmitters that have input powers up to 100 watts SSB/CW or 75 watts AM.

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Lower prices on KK IC's

Fairchild has reduced the already-low prices on the integrated circuits used in WB6AIG's Kindly Keyer in the July issue. The old price on the JK Flip Flops was $3.95; the new is $1.50, not a bad price for a tiny package containing 12 transistors and 16 resistors. The Dual Two Input Gates were $1.65. Now they're only 80¢.

Somehow the price and source of the etched circuit board used in this keyer was left out of the article. The board is small and a real horror to make and drill with its 120 tiny holes (part of them number 60), so it would probably be a lot better to buy than make. At any rate, the fiber glass board with all holes drilled is $4.95. You can buy it from Harris Company, 56 E. Main Street, Torrington, Conn.

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SB-300: CW, SSB, AM filters: 75 S-1: noise blanker; $250.00 each f.o.b., Ed Jurow, 20314 Harding, Olympia Fields, Ill.

GALAXY V. Remote VFO, VOX, AC Supply, and Speaker-Cabinet $495. Gonset GSB-201 $190. All offers considered. John T. Null, 407 38th Street, Vienna, West Virginia 26101, 304-295-5616.

SP-600-JX-1 receiver with manual $275.00, Valiant F/W $200.00, HQ-145C with speaker $160.00. Want KW power supply. K1NLW, Glenn Edson, 16 Monticello Dr. Paxton, Mass. 01612.

BUILD A CODETYPER. Transistorized electronic computer-typewriter for Morse teaching or keying your rig with fb fist. For schematic, parts list and technical dope send $2 to Computronics Engineering Box 6606 Metropolitan Station Los Angeles 90056.

MOHAWK RECEIVER and matching speaker for sale. Moved into housing project and cannot use. Excellent condition. $150. Brooklyn, N.Y. Call 996-7837 after 7 or weekends.

TECH MANUALS: Special $3.00 each—ARC-27, CV-116/URR, ARN-30, TS-186D, BC-1031. Many others, list 10¢. S. Consalvo, W3IHD, 4905 Roanne Drive, Washington, D.C. 20021.

EICO 723 $35, Mosely TA-33 Jr. tribander $45. Both nearly new. Or swap for 2 meter transmitter, converter. Pete Hunt, 41 Woodcock, Levittown, N. Y. 11756.

YOUR CALL LETTERS on a 7x2½ steel plate, white on red, weatherproof. For car and shack. Limit 5 characters. $2.00ppd. 2 for $3.75ppd. METHODS 1011A Bush St. San Francisco, CA 94109.

WRL'S BLUEBOOK SAVES YOU MONEY! These prices without trades: KWM2—$675.00; NCX3—$197.10; GALAXY 300—$161.10; NCL2000—$399.60; HT37—$233.10; HX20—$152.10; GLOBE KING—$179.10 up; 75S1—$278.10; SX117—$206.10; PMR8—$67.50; HQ170C—$197.10; 2A—$161.10. Hundreds more, free list. WRL, Box 919, Council Bluffs, Iowa 51501.

LI'L LULU 6 METER TRANSMITTER. Purchased Spring of '65, like new, never mobile. Complete details on request. WAØILV, Frank Miller, Clarkson, Nebraska 68629.

COMPLETE STATION: Knight T-60, R-55A receiver, Eico 722 VFO. All excellent, $100 or $35 each. Charles Jimenez WA4ZQO, 17001 Northwest 53rd Court, Opa-locka, Florida 33054.

HW-22 with HP-23 power supply. Sell or trade for comparable value receiver. W. Ellinwood W1MPY 758 Pleasant St. Athol, Mass. 01331.

FM FOR 2, 6 AND 432. Motorola 150MC base stations (140BY) $140. Motorola 432MC transceivers T44A6A 6/12V. These are clean and complete, with every tube, crystal, cable, control head, mike, speaker and case. Guaranteed operating. Complete manuel with every unit. Rated 18-20 watts output. Require no modification to get on 432MC. $75 each. Go where the action is: get on 432.9 wideband FM. Over 25 stations in Detroit area on this frequency. 432.9MC xtals available for most FM equipment (inquire). Just arrived: lots of clean 150MC 12V transceivers, with manuels. Send for latest list (S.A.S.E. appreciated). Newsome Electronics (Ray, K8TJP), 2670 Pinetree, Trenton, Mich. 48183.

HAVE COLLINS 75S3, 32S3, 62S1 and 516F2, Johnson 6N2 Thunderbolt. WANT 16 mm movie outfit. K71MH James F. Bingham, P.O. Box 516, Beaverton, Oregon. 97005.

EICO 753 TRANSCEIVER with transistor V.F.O. $180.00. EICO mobile transistor power supply $70.00. Both excellent. Don Norman K8LLZ, 204 Emerson Court, Elyria, Ohio.

TWO BEDROOM FRAME HOUSE on large 52' by 170' lot. Land values are still climbing. Has good potential. Will sell completely furnished (ham gear not included but will consider leaving 60' tower, rotor and beam behind) panoramic view of downtown. Good residential neighborhood. Stores, schools, etc. close. Asking $26,900. Call or write Iverson, WA6ZCQ 1312 Micheltorena Street, Los Angeles 90026. Phone No. 3 1581.

SB-33 SB1LA L.P. filter, New condition with manuals—original boxes. Transceiver tunes 1 50KC of transmitter freq. $350. W1DFN 59 Tahattawan Rd. Littleton, Mass.

WANTED: TELETYPE EQUIPMENT R-388, 51J-3 R-390A. Cash, or trade for new amateur equipment. Alltronics-Howard Co., Box 19, Boston, Mass. Tel-617-742-0048.

NCX5 TRANSCEIVER—NCX-A Power Supply, Perfect—used 20 hours $425.00 WA4GYA, 2207 Harvard, Ft. Myers, Fla. 33901, Phone WE. 6-1726.

WANTED: BC 221—Original-Calibration Book—Accurate—Good condition. No modifications. Full details and price. Tel 899-7570. Howard Ell, 206 Pearce Ave. Point Pleasant, N.J.

LIKE SIDEBAND? SWAP like new HT37 for Heath Apache or Viking Valiant. C. J. Dixon, K9BQW, 18186 Chicago Ave., Lansing, Illinois 60438.

300 WATTS SSB TRIBAND transcriver galaxy 300 with power supply—excellent condition, $250—Tony Aasenza, 10724 Campana Way—Rancho Cordova, Calif. 95670.

LOW MILEAGE DELUXE DRAKE 2B and HT-37 with coax-relay, microphone. $450 firm. HO-10 excellent, $45. B. Binder, 26 Sarah Drive, Spring Valley, N. Y. 10977. 914-352-1482.

DRAKE 2A RECEIVER, speaker $125. C. E. 20A and VFO $75. Sorry no shipping. R. Mensing 3160 Waverly, Palo Alto, Calif. 326 5884.

QSL CARDS????? WHOLESALE prices. "America's Finest" Samples 25¢ DeLuxe 35¢. Sakkers Printery, W8DED, Box 218, Holland, Michigan 49423.

TO 18 FIELD EFFECT TRANSISTORS $1.95, resistors, capacitors, transistors, diodes, and many other bargain packs send for list to: Solid State Pax. P.O. Box 206, Dorchester, Mass. 02014.

ESTATE SALE and bargain list. Send for it and include SSAE. Write Paradd Sales and Engineering Service, 280 Route 10, Dover, N. J. 07801.

TRADE: Preamp CQ May '63 3 nuvistors 10-80M; Wen 2 speed ⅜" drill Wlacc; Hy-Gain 4BD W1100' RG 59 u 6-20 M. OFFER: Stephen Clifton, 800 W. End Ave., N. Y., N. Y. 10025.

RTTY GEAR for sale. List issued monthly. 88 or 44 Mhy toroids five for $1.75 postpaid. Elliott Buchanan, W 6 VPC, 1067 Mandana Blvd. Oakland, Calif. 94610.

FOR SALE: BC610E; BC 614 Speech Amp; KWS1; 32V1; ART 13; R388 Recv'r. W2ZOL.

EXCESS GEAR AND PARTS, vac, variables, variable coils, tubes, meters, transformers, 2kw linear, diodes (HV), etc. Stamp for complete list. W6MCS, Rt. 1, Box 666, Arroyo Grande, Calif.

FOR SALE: COLLINS STATION $1100.00. 75S-1 with Waters Q-multiplier, matching speaker $325.00. 32S-1 with 516F-2 power supply $450.00. 30L-1 Linear $425.00. Purchased new. Kept in air conditioned quarters. Absolutely perfect, mint condition. Will bear most scrupulous inspection. New Avionics gear considered. K9DMG, Perry Mowery 21 Waibel Road, Bartonville, Illinois, Phone 697-6597.

FANTASTIC HAM LOCATION atop 1000' hill 180° view of Pacific Ocean Antenna OK Two story 3 bdrm 2½ bth. 2 dens 2 yrs old. shop area B. Ward WB6DLQ 3149 Altalaguna Blvd. Laguna Beach, Calif. Tel (714) 494 6110

SBE-33 with mike and DC supply $250.00; SB1LA matching Linear $150.000; DX60A $65.00; HG-10 VFO $30.00; WØNAE, James R. Boyer, R.R. #3, Watertown, South Dakota, 57201.

WANTED: MODEL 28 TELETYPE, R-388, R-390A, cash or trade for new amateur equipment. New NCL-2000, $500. Alltronics-Howard Co., Box 19, Boston, Mass. 02101. 617-742-0048.

STARTING HAMMARLUND HX-50; HX-50A; Problem Information Group. What problems-troubles have you had??? Data will be tabulated and available no charge. WA3CJC- 218 Cook Avenue, Ridgway, Pennsylvania, 15853

1296 MC MOONBOUNCE EQUIPMENT, crystal control, receiver, transmitter, paramp, 16 foot fiberglass dish, SCR-584 autotrack, pedestal; offer over $1,400 takes, F.O.B. Chiloquin, Oregon, Steve Mieth, K7VXC, Box 324.

EXCEPTIONALLY GOOD EQUIPMENT. Hallicrafters SX-101A-$250, Johnson Valiant—$250, Hy-Gain TH4 & Ham-M with cables—$110, RCA 155 C oscilloscope $25. Will negotiate on the lot. Substantial associated equipment. Bob Yarmus, K2RGZ, 532 Lefferts Ave., Bklyn, N. Y. 884-6336 or SL6-7044 after 6 P.M.

INDEX TO ADVERTISERS

Propagation Chart

AUGUST 1966

J. H. Nelson

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	7*	7	7	7	7	7	14	14	14	14
ARGENTINA	21	14	14	14	7	7	14	14	21	21	21*	21
AUSTRALIA	14*	14*	14	7*	7*	7	7	14	7*	7#	14	14*
CANAL ZONE	21	14	14	7*	7	7	14	14	14	21	21	21
ENGLAND	14	7	7	7	7	14	14	14	14	14	14	14
HAWAII	14	14	14	7#	7	7	7	7#	14	14	14	14
INDIA	14	14	7#	7#	7*	14#	14	14	14	14	14	14
JAPAN	14	14	7#	7#	7	7	7	14	14	7#	14	14
MEXICO	14	14	14	7	7	7	14	14	14	14	14	14
PHILIPPINES	14	14	7#	7*	7#	7#	14	14	14	14#	14#	14
PUERTO RICO	14	14	7	7	7	7	14	14	14	14	14	14
SOUTH AFRICA	14	7	7	7#	7#	14	14	14	14	14	21	14
U. S. S. R.	7	7	7	7	7	14	14	14	14	14	14	14
WEST COAST	14	14	14	7	7	7	7	14	14	14	14	14

CENTRAL UNITED STATES TO:

ALASKA	14	14	14	7	7	7	7	7	14	14	14	14
ARGENTINA	21	14	14	14	7	7	14	14	21	21	21	21*
AUSTRALIA	14*	14*	14	14	14	7	7	14	7#	7#	14	14*
CANAL ZONE	21	14	14	14	7	7	14	14	14	21	21	21
ENGLAND	14	7	7	7	7	7	14	14	14	14	14	14
HAWAII	14	14	14	14	7	7	7	7	14	14	14	14
INDIA	14	14	7#	7#	7#	7*	14#	14	14	14	14	14
JAPAN	14	14	14	7#	7	7	7	14	14	7#	14	14
MEXICO	14	14	7	7	7	7	7	14	14	14	14	14
PHILIPPINES	14	14	14	7#	7#	7*	7#	14	14	14#	14#	14
PUERTO RICO	14	14	14	7*	7	7	14	14	14	14	14	14
SOUTH AFRICA	14	7	7	7#	7#	7#	14	14	14	14	14	14
U. S. S. R.	7	7	7	7	7	7	14	14	14	14	14	14

WESTERN UNITED STATES TO:

ALASKA	14	14	14	14	7	7	7	7	14	14	14	14
ARGENTINA	21*	21	14	14	14	7	7	14	14	21	21	21*
AUSTRALIA	21*	21*	21*	14	14	14	14	7	7#	7#	14	21
CANAL ZONE	21	14*	14	14	14	7	7	14	14	14	21	21
ENGLAND	14	7	7	7	7	7	7	14	14	14	14	14
HAWAII	21*	21*	21	14	14	14	7*	7	14	14	14	21
INDIA	14	14	14	14	7#	7#	7#	7*	14	14	14	14
JAPAN	14	14	14	14	14	7	7	7	14	14	14	14
MEXICO	14	14	7	7	7	7	7	14	14	14	14	14
PHILIPPINES	14	14	14	14	14	7*	7*	7#	14	14	14#	14
PUERTO RICO	21	14	14	14	7*	7	7	14	14	14	14	14
SOUTH AFRICA	14	7#	7	7#	7#	7#	7#	14	14	14	14	14
U. S. S. R.	7	7	7	7	7	7	7	7*	14	14	14	14
EAST COAST	14	14	14	7	7	7	7	14	14	14	14	14

Very difficult circuit this hour.

* Next higher frequency may be useful this hour.

Good: 1-3, 6-8, 14-18, 21-27
Fair: 4, 5, 9, 13, 19, 20, 28, 30
Poor: 10-12, 29
VHF DX: 8-10, 14-17, 21, 29, 30

73

OCTOBER 1966

A Sixth Anniversary 60¢

Amateur Radio

73 Magazine

ayne Green W2NSD/1
blisher

ul Franson WA1CCH
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lvertising Manager

tober 1966

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ver by Sid Willis

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de W2NSD/1

never say die

de W2NSD/5Z4

This is being written while on "safari" in the remote wilds of northern Kenya. I put safari in quotes because the 1966 concept of a safari over here is probably quite different from anything you have in mind. It certainly is different from the stories I have read and movies I have seen down through the years of safaris. Perhaps I should disclaim here: readers who want only ham info in their ham magazine should turn to the next article because there is absolutely nothing of amateur radio to follow. Readers who have mistaken 73 for Holiday or Venture may be interested in the adventures of a newcomer to Africa.

The trip over here from Boston was supposed to take just one day. Jim Cotten W5PYI

Wayne with guides and waterbuck.

and Larry Frank WA6TCI arrived on Monda night and I picked them up in Boston an drove them up to the 73 headquarters for day of getting acquainted. Larry had bee with me in 1963 on the 73 tour of Europ On Tuesday we finished our packing and ha a long QSO with Robby 5Z4ERR in Nairob Robby answered a lot of our questions for u When we finished our QSO with Robby w were called by 9Q5HF in Linga in the Cong We are planning on visiting Ed after our safa and visit to Kenya. Ed assured us that w could visit the Congo in perfect safety. Tha was comforting.

Jim Fisk WA6BSO/1, who is minding th button factory while I'm away, drove us a down to the airport Tuesday evening. We ha gone to lengths to make sure our baggage wa within the weight limit of 44 pounds eac providing they didn't weigh us with our han luggage. Our flight was by Alitalia to Rom and then, with about a two hour delay, Alitali on to Nairobi. With everything connectin right we should leave Tuesday evening an arrive in Nairobi the following evening. I took us three days to get to Nairobi.

The flight started off an hour late, makin us a little nervous about that connection i Rome. They had oversold the tourist compart ment and the three of us had to suffer throug the ten course dinner and champagne of th first class section. The seats were much large and roomier too, but not really comfortabl enough to promote much sleep. We arrived th next morning in Rome rather pooped. OK where do we find the Nairobi plane? Th Alitalia people looked nervously at each othe Where is it? Well, you see, we er . . . ah . . had to cancel that flight. Today is Wednesda and we think we will have another flight o Saturday. Certainly by next Tuesday. In th meanwhile you will be the guests of Alitali You will stay at a nice hotel with rooms a meals paid.

How about alternate ways of getting t Nairobi? No, very sorry, but we have checke that and all flights are fully booked. You'd bes wait for our Saturday flight. Most of the peopl caught in this situation just gave up and we to the hotel. Not us. Jim grabbed an airlin manual and started looking up possible wa of getting from Rome to Nairobi . . . via any where. Of the many possibilities the be seemed via Tel Aviv or via Athens. We trie for reservations on these two paths and bot came through for us. We flipped a coin and was Athens. That would get us into Nairob by Friday noon.

(Continued on page 96

Integrated Circuits

How will they affect you?

Tiny integrated circuits are making a big noise in the electronics industry. In the past year or so, they've just about taken over the jobs once held by transistors in computers. Now IC's are creeping into consumer products like TV sets and portable radios; they may take them over completely in a few years.

So what are integrated circuits? What do they do? How are they different from more familiar electronic components? How are they used? And most important, how will they affect our hobby? I hope this article will give a short, if incomplete and oversimple, answer to these questions.

What are integrated circuits?

Integrated circuits are electronic circuits made from miniature electronic components mounted on small insulators. Some IC's have been around a long time. Remember the flat Couplates used in radios and TV sets? These small ceramic plates with resistors and capacitors printed on them can take the place of many larger individual components. Couplates are simple integrated circuits.

IC's can offer these advantages over conventional components and construction:

Versatility
Reliability
Light weight
Low power requirements
Low cost per function
High input impedance
Wide frequency response
Small size
High gain
Low phase shift
Simple external circuitry
Easy gain control

Possible disadvantages of IC's compared to conventional circuitry:

Parasitic capacitances between components
Parasitic transistors and diodes
Only small capacitors can be used (under 500 pF)
Only small resistors can be used (under 100 k)
Inductors can't be included in IC's
IC resistors aren't precision
IC resistors have high temperature coefficient
An individual can't design his own IC's
"IC circuitry is different" complain some hams

But the IC's that are attracting so much attention now are different from earlier ones. They contain not only resistors and capacitors, but also diodes and transistors. These integrated circuits are of two types: *monolithic* and *hybrid*. A monolithic IC is formed from a single chip of silicon. Components and conductors are etched on its surface by clever photographic and chemical processes. The chip is mounted on a small terminal block with thin wires soldered from the proper places on the surface of the chip to the terminals. Then the whole assembly is mounted in a sealed case or dipped in plastic for protection.

A hybrid integrated circuit is basically a monolithic IC chip with small components made from thin films of nichrome or other materials mounted on its surface. These films can be used for components that can't be made from silicon, such as high-value resistors. Another name for this type of integrated circuit is *thin film*.

Most IC's have been made from silicon, but experimental ones have used other semiconductor materials. The transistors in present commercial IC's are conventional bi-polar devices, but various types of uni-polar transistors such as field effect transistors have been used. IC's using *FET*'s probably will become more popular as their prices come down.

It's easy to draw the schematic of an IC since it's composed of more-or-less conven-

(Continued on page 120)

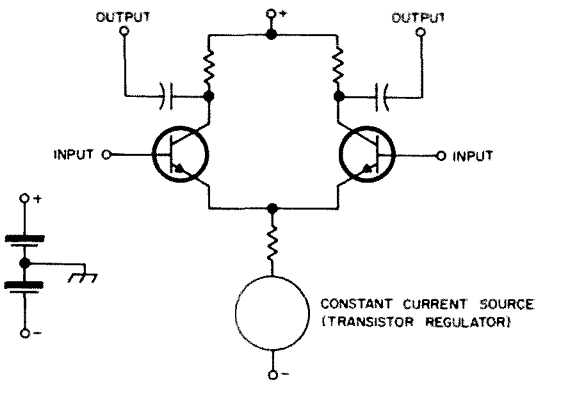


Fig. 1. Schematic of a very simple, but typical, type of integrated circuit.

Ed Marriner W6BLZ
528 Colima Street
La Jolla, California

El Marrinero

A Portable SSB 80 m Transceiver

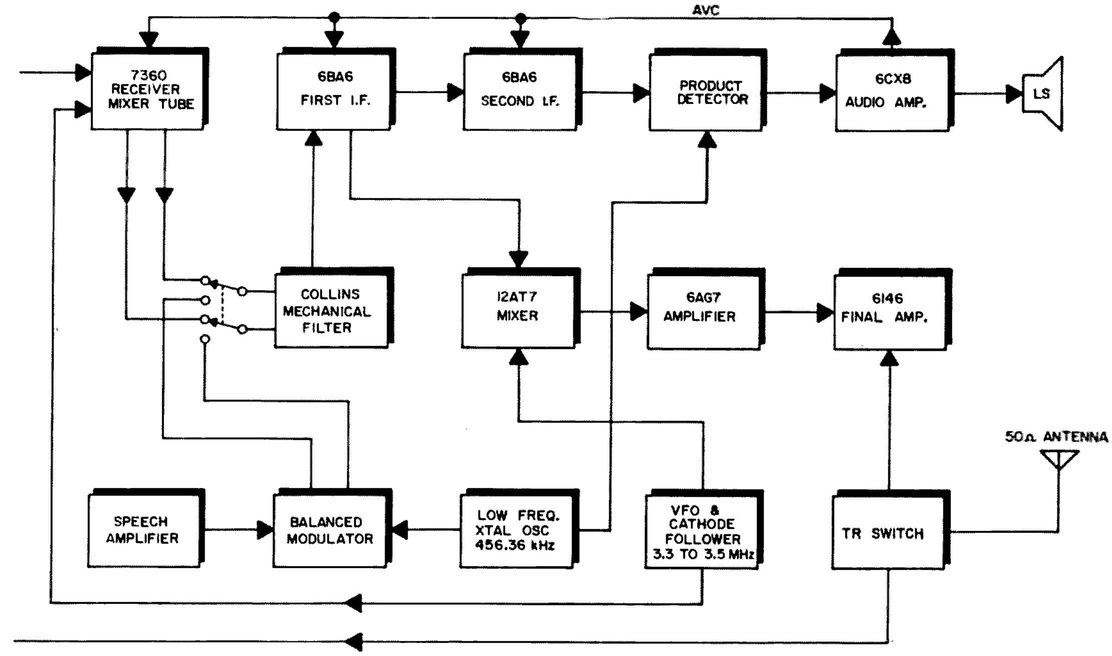
This is an 80 meter SSB transceiver for the man who hasn't everything. It has an input of about 70 watts, and is built out of old standard radio parts, partially because they are cheap. Call it a pre-historic monster if you wish; it works fine. The only argument for building this rig is that it is a complete unit with the power supply all on one chassis, and it is a little cheaper than buying a one-band kit. It might take a little too much experience for the average amateur, but the old soldering iron artists should not have too much trouble with the straightforward circuits.

The original idea for building this transceiver was to have something around the shack that could be taken on vacation trips without worrying that knocking around would destroy its resale value. The time spent building the rig, however, left some pensive thought on the future of amateur radio. Let's face it, gone are the days of building an oscillator-amplifier rig in one afternoon, it took several months to turn this one out. You have to be a real nut to build anything these days. It should not be too far in the future when all you have to do is go to the radio store and buy a transistor board all made up and just plug in the parts. Why not? All of the circuits are worked out and are standard.

There are today plenty of amateurs in all parts of the world who are not as lucky with their dollars as we in the U.S.A. They are also tied up with import taxes and the high cost of radio parts. They still are high up on the list of surplus part users, so this article will be a big help for them. This rig is small and came out about the same size as any transistorized rig using the equivalent power input. It should do the job for the boys overseas because it is portable, compact, and yet cheap. If this proves anything, we might say that the old parts still have some good qualities, and are still mechanically reliable, even though it may not be progress if that is what we must have in our radio magazines.

Theory

This SSB transceiver tunes from 3.75 to 4.0 MHz using a VFO made with the variabl capacitor taken out of an ARC-5 transmitte for vernier tuning. The input to the transmitter portion is about 70 watts PEP, and the ri

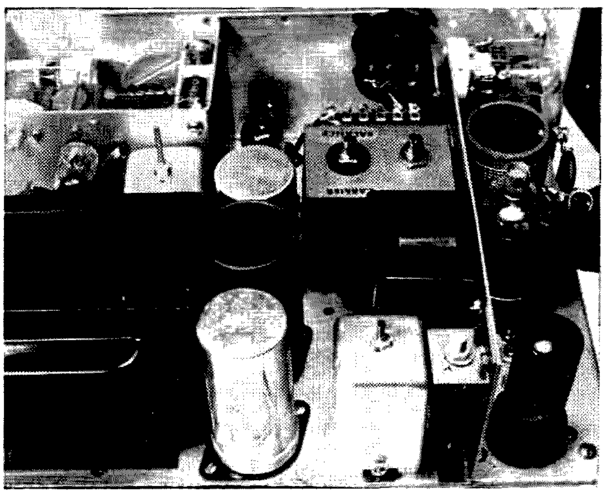


ig. 1. Block diagram of El Marrinero, a portable 0 meter SSB transceiver built by W6BLZ. The circuit is quite simple for a sideband transceiver. Optional VOX is shown in Fig. 6.

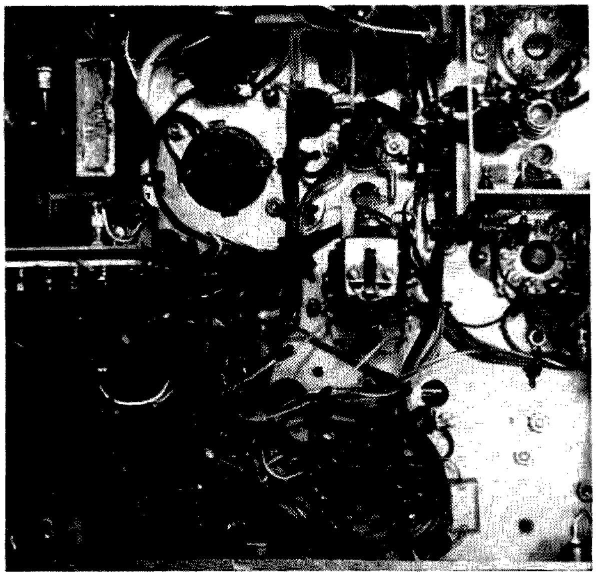
; all self-contained with the 700 volt power upply all on one chassis. It uses a Collins 455 Hz mechanical filter which can be obtained y sending $26.50 to Mr. Don Iacoboni, Colins Radio, 19700 San Joaquin Road, Newport Beach, California. Ask for the amateur type ilter, F-455-FB-2.1 with a 2.1 kHz bandvidth. This unit is cheaper than the other ilters used in commercial equipment.

Here is how the rig works: The block diagram is **Fig. 1**, the schematic **Fig. 2**. In the eceiving section a 80 meter signal from the ntenna passes through a TR switch composed f a 6 watt 120 volts lamp and two diodes, md is fed into the antenna coil. The tuned ignal is then applied to the grid of a 7360 nixer tube directly without any rf stage. Here he signal is mixed with the VFO and comes ut at 455 kHz and fed into the mechanical ilter by two relay contacts. The input and utput of the filter is tuned to 455 kHz by a ixed 130 pF capacitor across its input and utput. After passing through the filter the ignal is amplified by two stages of 6BA6 *if* mplification, detected in a product detector nd then audio amplified. AVC is obtained by ectifying voltage from the first audio tube nd applying it to the 7360 and the two *if* ubes. It is simple and effective.

In the transmit position the low frequency crystal oscillator (456.360 kHz) is applied to a diode ring modulator and combined with the audio speech. The output of this modulator is sent through the filter by relay contacts, and amplified by one stage of 6BA6 *if* amplification. The plate voltage is applied to this tube at all times because it is used in both transmit and receive position, while the second *if* tube is only used in receive position. After the signal comes out from the first *if* amplifier it is mixed with the VFO signal (3.3-3.555 MHz) in a 12AT7 mixer and comes out in the 80 meter phone band. (This include the Canadian portion) The five volts of rf produced by this mixer is enough to drive a 6AG7 driver tube that in turn drives a 6146 which has about 600 to 700 volts applied to its plate, at about 150 mA. The output signal is coupled to a coax 52 ohm line by tapping up from the ground end of the coil. This works satisfactorily and makes for simple tuning



Back view looking toward the front panel. The carrier balance pots were later moved to the front panel for operating convenience.



Bottom view. The base of the 6AG7 driver is shown in its shielded compartment.

compared to a pi network. A small antenna tuner can be made with broadcast type receiving capacitors, or fed directly into a di-pole or mobile whip type of antenna.

It should be pointed out here this rig can only be used on 80 meters because it is single conversion. The VFO being only 455 KHz away from the output signal would prohibit a tuned circuit from tuning it out on 7 MHz. It could be done with more tuned circuits. More tuned circuits are necessary as you increase in frequency to accomplish the same rejection.

Construction

This transceiver is built in a California Chassis cabinet LTC #470 which has included a chassis 5¾ x 11$^{9}/_{16}$ x 8¾ inches. Layout is shown in **Fig. 3.** Since this rig was a breadboard there might be a better arrangement, and an experienced constructor might find it desirable to re-arrange some of the parts. If parts are placed in other positions be sure and keep the 7360 as far away as possible from any choke or power transformer field to prevent its being modulated. It is a good idea to keep the audio section shielded off from the diode rectifiers, and filter chokes. Diode rectifiers often develop large transient signals which can be picked up in a high gain audio amplifier if it is too close. This receiver is absolutely clean from hum and diode switching noise in the parts placement shown.

The constructor might have thoughts of using a variable capacitor to gang tune the slug coils for the mixer-driver-amplifier. If this is done good shielding will have to be used to prevent picking up rf causing oscillations. Keep even the slug coils small. Using fixe 250 pF mica capacitors across the coils tuning range across the 80 meter phone ban is satisfactory without too much falling off (drive without re-adjustment of the slugs.

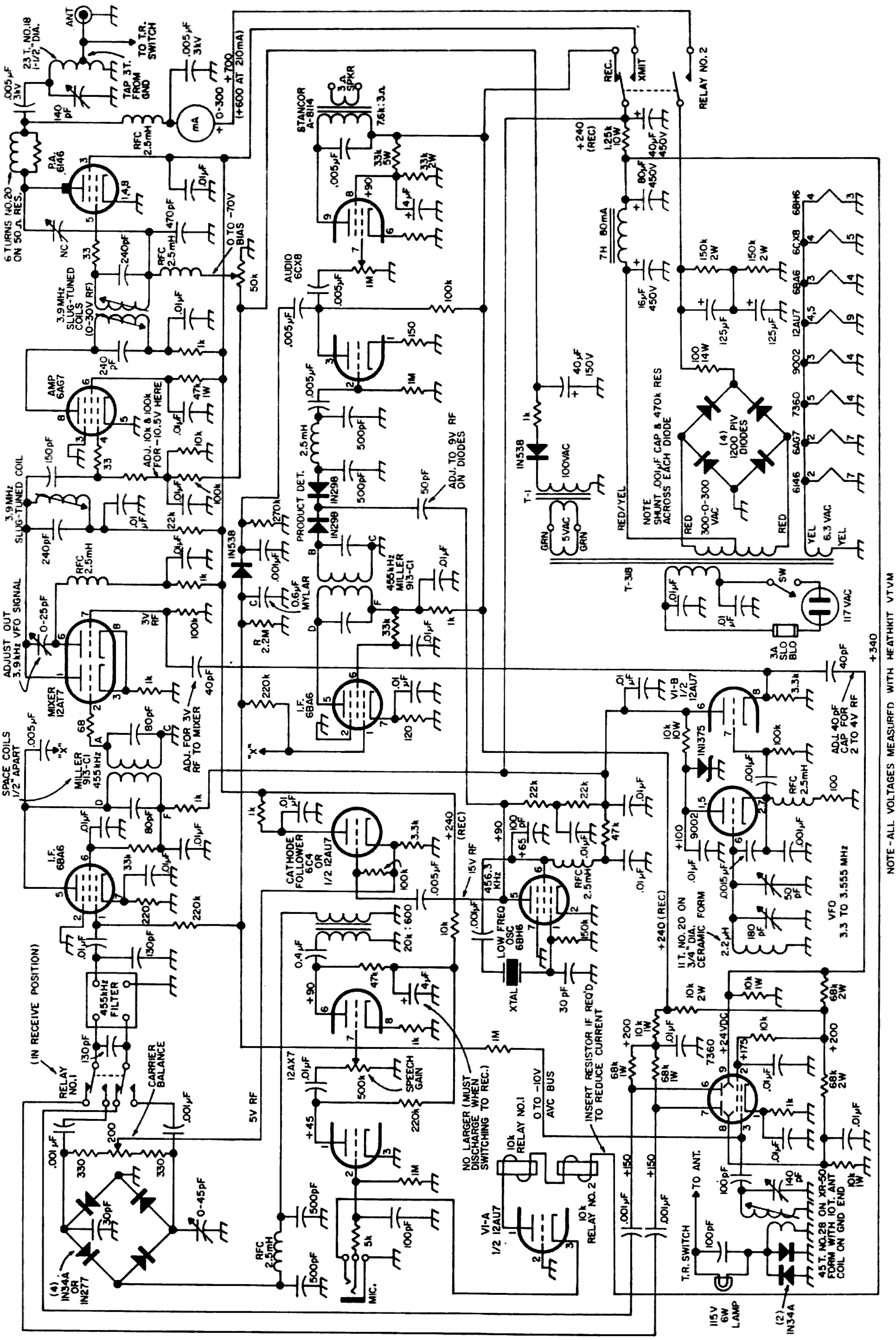
One of the main feature of this transceive is that the power supply is mounted on th chassis. More space could be saved if a tran: former could have been obtained with a bi: winding, but this transformer only cost $2.9: and it has a filament 6.3 volts at 9A, and th secondary handles 210 mA.

Construction was started by mounting th power supply in one corner of the chassis an wiring it so that the available voltage coul be used to check out the circuits as they wer completed.

Next in line was building the VFO and the finishing the receiver portion. Nothing wa finished until the receiver was operating, an then construction was continued on the tran: mitter section.

Low frequency crystal oscillator

Since most amateur operation on 80 mete SSB is on the lower sideband, and becaus crystals are expensive, only the 456.360 kH crystal was used. This crystal can be obtaine by writing to Mr. P. M. Freeland, Interna tional Crystal Co., 18 North Lee street Okla homa City, Okla. and asking for the speci: amateur crystal for this frequency in a F-60 holder. It will cost about $8.00. If this is to much the other solution is to buy a 50 cen surplus crystal marked Channel 46 and edg sand it down to the proper frequency. Some times by buying a number of these surplu crystals, one will be found that is good enough, or far enough down on the slope o the filter that it will sound okay. The crystal are spot welded to the crystal with smal wires, but if a holder is made with a clothes pin and held carefully the edge can be sande on sandpaper enough to increase the fre quency. These crystals are more sluggish t make oscillate and a 60 mH rfc may have t be used in the grid of the 6BH6 oscillato rather than the 2.5 mH shown. It is a goo idea to use the 6BH6 as some tubes just don' work. Many oscillator circuits were tried an this particular circuit gave the most output At first the 30 pF capacitor was not used fron the grid to ground but the oscillator did no come on every time. Various values were trie and the 30 pF seemed to be the best compro mise. The crystal oscillator puts out 15 volt of rf and it was found that 6-9 volts wer necessary for the product detector. If les voltage is applied to the detector loud signal do not mix. The cathode follower was neede



NOTE-ALL VOLTAGES MEASURED WITH HEATHKIT VTVM
P.A. 6146
AMP 6AG7
MIXER 12AT7
I.F. 6BA6
AUDIO 6CX8
PRODUCT DET.
CATHODE FOLLOWER 6C4 OR 1/2 12AU7
LOW FREQ OSC 6BH6
VFO 3.3 TO 3.555 MHz
RELAY NO.1
RELAY NO.2
T.R. SWITCH
STANCOR A-8114
455kHz FILTER
CARRIER BALANCE
SPEECH GAIN
MIC.
AVC BUS

Fig. 2. (Opposite page). Schematic of El Marrinero. A .01µF capacitor between the 200Ω carrier balance pot and the cathode follower.

because both signals could not be taken from the same point because of the by-passing effect of the .01 µF in the ring modulator. It just shunted the signal on the detector to too weak an output. The solution of taking the product detector from the oscillator plate and varying the coupling capacitor (50 pF) value to the product detector, a 6-9 volt rf signal could be set. The 100 kΩ resistor on the grid of the cathode follower does not load the oscillator down and the signal for the modulator can now be taken off from the 3.3 kΩ cathode resistor which is now a low impedance point. This better matches the diode modulator and we have 5 volts here to apply to the arm of the balance potentiometer.

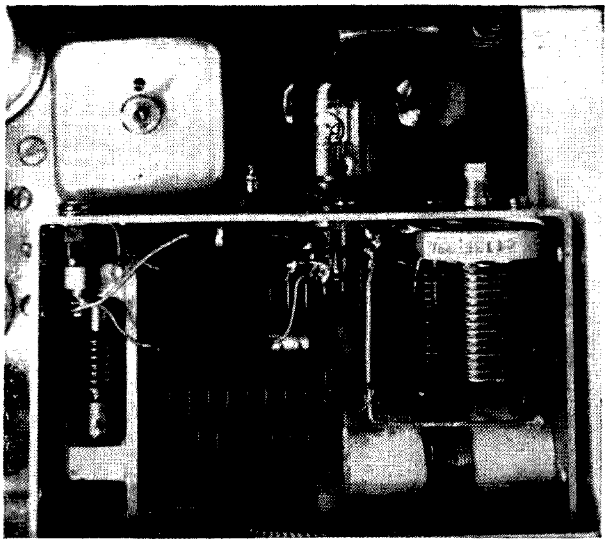
While we are talking about the ring modulator it could be mentioned some of the early photographs of the rig showed the balance pot above the chassis on a bracket. It was later moved to a panel control, which in conjunction with a pF trimmer capacitor nulls out the carrier. The pF balances out the fixed 30 pF added on the other side of the modulator to obtain a greater null. This is necessary because the pot has a metal cover and being bolted to the chassis has unbalanced capacitance. It was found un-necessary to use the extra capacitors if the pot was insulated from the chassis.

The vfo

Because of the high value of shunting capacitance across a small inductance this oscillator is mechanically and frequency stable. To me it is amazing having built many type of oscillators that seemed to drift forever. Theory is probably un-necessary since the 180 pF variable capacitor from the ARC-5 transmitter padded with a 50 pF APC type capacitor, and 12 turns of #20 en. wire wound on a ¾ inch ceramic form just tunes the 3.75 to 4.0 MHz amateur phone band. The oscillator itself of course is tuning 3345 to 3555 kHz.

A cathode follower was used after the VFO to prevent any pulling effect on the oscillator which might or might not occur. If the VFO was just used in a receiver the follower would not be needed. It might seem strange that a 9002 tube was used for the oscillator in place of the 6C4. Either one will work, but the 9002 is smaller and could be fitted between the box and transformer with no room to spare.

No measurements have been made on the oscillator stability, but from a cold start it does not drift off from a SSB signal. It has been used in several receivers with excellent results without any temperature compensating.



VFO box. Note the coil wound on the ceramic form.

Receiver

Pages have been writen in QST on the merits of using the 7360 tubes as a front end and mixer because of its low inter-modulation. We used it to do away with an rf stage. It was found the grid coil should be an air wound large coil if possible for the best selectivity. The 4.5 MHz sound *if* cans were tried and found too broad. Because of room restrictions a compromise was used by winding 28 turns of #28 wire on a XR-50 coil form with ten turns on the bottom for the antenna. It works half way between the two other coils and is satisfactory. During the experiments with this tube several rules must be followed, the supply must be set at 200 volts by adjusting the 10 kΩ 2 watt value of resistor. Otherwise the 1200 ohm cathode resistor value might have to be changed. In some instances the plate load resistors have to be lowered to 27 kΩ and the cathode resistor varied for best output mixed signal if a lot of output is desired. The cathode value can go as low as 600 ohms. When building this mixer observe that the accellerator has 175 volts on it, the two plates 150 volts and 2 to 4 volts of rf from the VFO to swing the beam. If these tolerances are held there should be no problem. AVC can be put on the tube after the receiver is finished and for preliminary adjustment the AVC bus can be taken off and the 100 pF coupling capacitor left out if desired. There seems to be some advantage in using AVC on this tube where strong local signals are heard.

The signal from the 7360 mixer is fed into the mechanical filter which is tuned by a 130 pF capacitor. Whether this value applies to all

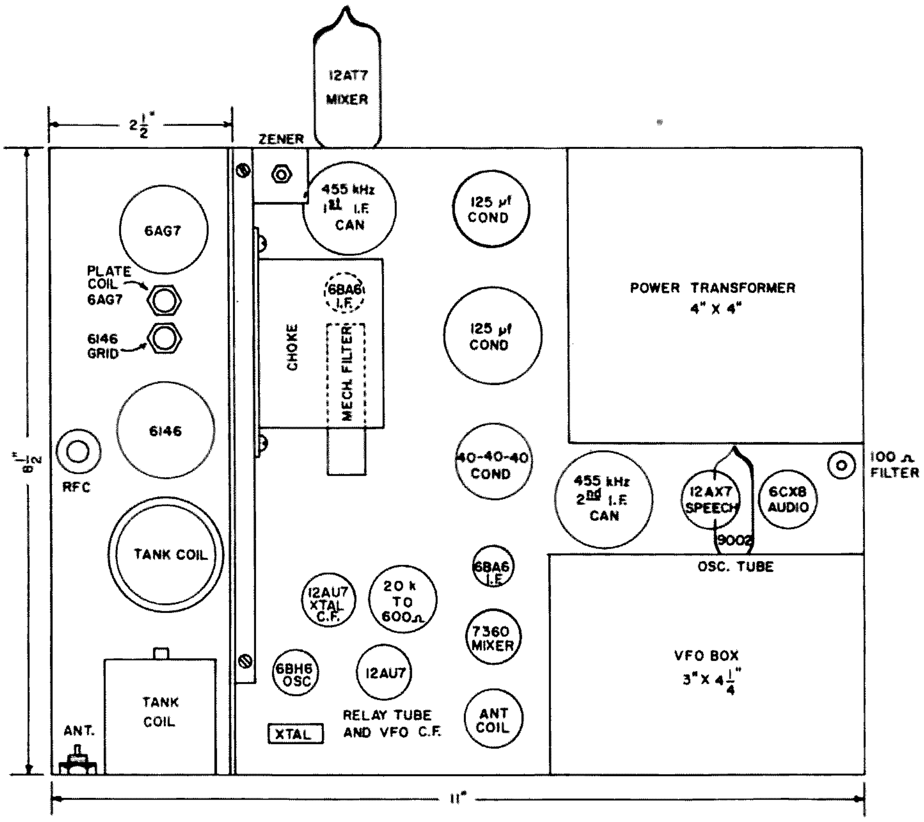
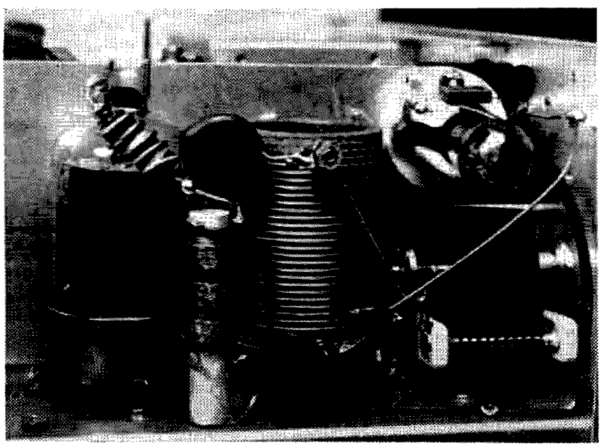


Fig. 3. Layout of El Marrinero as built by Ed Marriner W6BLZ.

Collins filters is unknown but should be very close to a practical value. This one was found by putting a variable capacitor across the filter and tuning it for resonance and measuring the value.

If stages 455 kHz

When the signal comes out of the filter it goes into a 6BA6 *if* stage. Here is where most constructors run into trouble trying to prevent the stage from oscillating. In anticipation the cathode resistor was increased from its normal value of 68 ohms to 120 or 220 ohms and it is suggested that the new J. W. Miller 913-C.T. transformers be used. The grid tap on these has been placed one-third of the way down from the top of the coil to lower the grid impedance. You will notice that the coupling to the second *if* is taken off from the primary of the first *if* transformer by a .005 μF capacitor. Smile if you will, but it serves two purposes, it allows the mixer grid to return to ground and it gives more gain plus it stops oscillations. This coil incidentally was modified by squeezing the coils to within one-half inch of each other. This can be tricky but by scraping the glue from the rod and inserting a spacer one-half inch thick the coil can be pushed up against it by taking a piece of wood and drill a half inch hole in it and slipping it over the rod. If this is not done the pi will push out or the coils will two-block and won't come apart. (voice of experience!) It is necessary to push the coils together to obtain enough coupling to the 12AT7 mixer grid. The coupling from the primary to the second *if* does not effect the selectivity because we are using a mechanical filter.



Final amplifier, tank coil and TR switch.

Since the placement of the coils in this transceiver layout were six inches apart a piece of RG-174 was used to bring the signal from the .005 to the grid of the second *if* tube. This extra capacitance was too much for the 100 pF tuning the first *if* can and 80 pF had to be put inside the can in place of the 100 pF. The second *if* can tuned without modification.

Product detector

This product detector is becoming very

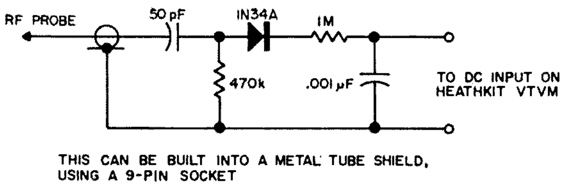


Fig. 4. RF probe for tuning up El Marrinero.

popular as it saves a tube. Just don't use silicon diodes or it won't work, there has to be internal leakage. The original circuit used IN67's but 1N298's and 1N38's have been used. The RFC keeps the rf from getting into the audio which might cause hissing. A 47 kΩ resistor works just about as well as the RFC.

This completes the receiver. To align it it would be nice to have a signal generator or a 455 kHz crystal, however, if you don't just tune in an 80 meter signal and peak the *if* cans for maximum output. Remember to ground the AVC bus before tuning.

The rectified audio used for the AVC will go up to 15 volts on loud signals. The length of time it holds up can be varied by changing the value of the 2.2 MΩ resistor and the 0.6 μF Mylar or low loss capacitor. The hold-up time can be watched on a VTVM voltmeter.

With an rf probe make sure that at the junction of the two diodes of the product detector have 6 to 9 volts. If there is not enough voltage such as 2 volts, the signals will sound distorted or not mixing. This can be very apparent if you just pull the crystal out if you care to see what it sounds like with no injection.

It might be mentioned that the screen of the 6CX8 must be by-passed with a heavy capacitor such as the 4 μF to obtain increased gain. With this by pass no capacitor is necessary on the cathode. The screen voltage is held constant by the 33 kΩ resistor voltage divider, making this tube different from using a 6AQ5 where it is not necessary.

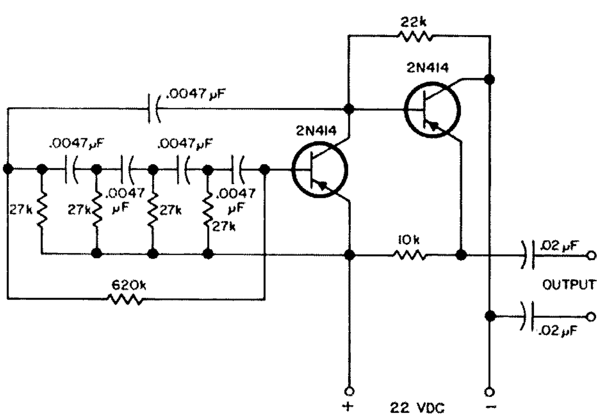


Fig. 5. 1200-Hz tone oscillator for inserting a signal into the microphone jack to produce a signal for tuning. Construction isn't critical.

Confidentially this is a pretty good receiver, simple and easy to build except for taming oscillations in the *if*'s.

Test equipment

There is no limit on the amount of test equipment that could be used when building SSB equipment. Many look with awe or askance when I say this rig was built with just a grid-dip meter, Heathkit VTVM and an rf probe and a borrowed RCA signal generator which had a variable output so that initial voltage injections could be found. A similar rig was built without the generator and only a 200-500 kHz receiver used to listen to the signal at 455 kHz before it was mixed. Most of the SSB trouble come from mixing or oscillations in the 3.8 to 4.0 MHz region of the driver or final amplifier tubes. A receiver in the 3-40 MHz frequency range would naturally be helpful listening to the VFO and the final signal but you could get by with just a GDO. Once the 80 meter signals are picked up you can use them to test and align the rig. The test gear ranges then from nothing to as much as you can lay your hands on. The more you fuss with building the gear, the less test equipment you need and more ways can be found to improvise. for any particular adjustment. I find a calibrated capacitor handy when trying to find out what value of fixed capacitor to put across a coil. A GDO is handy for finding a coil's resonance. A field strength meter is handy to balance out the carrier, or when tuning up into a dummy load. The old "Q" fiver tuning 200 to 500 kHz is nice to listen for the first squeek of life out of the 6BA6 *if* amplifier. At least you know you are SSB on 455 kHz. An rf probe is a necessity; see **Fig. 4.**

Transmitter portion

Here we are at the transmitter portion. When we are through with this article you have had a course in SSB transciever construction.

Many circuits were tried before ending up with this present configuration. Each time the rig was finished something new appeared to cause circuit changes. Originally a 7360 was used for the balanced modulator. It seemed to work fine most of the time, however, every once in a while carrier would appear. The trouble was traced to changing accelerator voltage, which caused upbalancing of the carrier. The tube being in the field of the choke also caused carrier imbalance as the field around the tube changed. The circuit was changed to the more stable diode ring modulator.

The circuit has been described up to he 12AT7 mixer where we squished the *if* :oil together to drive the grid of the mixer. The VFO signal was picked up by a field trength meter in the mixer output coil. The mall capacitor between its plates was varied intil the signal from the VFO was reduced nd the coil tuned up by feeding a tone into he audio input of the transmitter. The output f the mixer should be about 5 volts of rf o drive the 6AG7 which builds the signal up o 30 volts of rf sufficient to drive the 6146 in AB-1. A shield box was put around the 6AG7 ocket and a shield across between the grid nd plate pins to prevent oscillation. The sigal was carried to the 6AG7 grid by RG-174 :oax. The output signal to the 6146 grid comes hrough the box by a feed-through insulator. Jsing this shielding technique the 6146 did iot need neutralizing. Since the grid circuit of he 6146 is tuned and coupled to the tank coil f the 6AG7 inductively to prevent VFO feedhrough, it is prone to self-oscillation unless xtreme shielding is used. If tuning capacitors ind large coils are used they should be put n a box. For AB-1 operation the 6146 needs ibout 50 volts of bias. The 6AG7 bias is adusted for −10.5 volts so that the cathode can e grounded. This tends to make a more stable lriver tube arrangement.

Tuning of the transmitter can be accomlished by inserting an audio tone into the nicrophone input (See **Fig. 5** for a generator) r by unbalancing the carrier control knob lightly.

If you'd like to include VOX, the circuit or it is shown in **Fig. 6.**

Well, thats it, I'm proud of my little rig that goes with me on vacation trips. Despite the struggle getting all of the bugs out of it I had un finding out for myself how the various SSB circuits work rather than just reading the ook. I'm sure there are many improvements hat could be made but the rig sounds first class, and that is what counts.

. . . W6BLZ

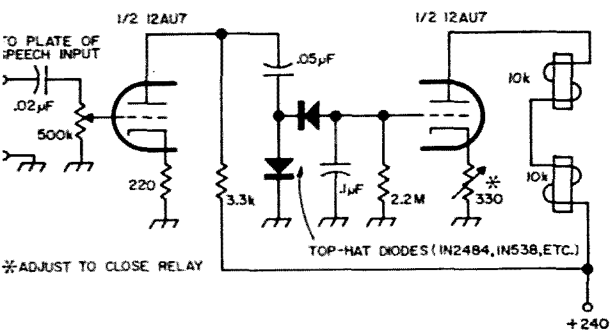


Fig. 6. Optional VOX circuit for El Marrinero.

Bob Heil K9EID
Holiday Inn East
Columbus, Ohio

Two Tubes for Two

Get on two meter sideband with only two tubes (and a 20-meter SSB transmitter, of course).

With the increase in activity and the tremendous amount of nightly QRM on the lower frequency bands, we are all forced to move up in the spectrum in order to enjoy our operations. Until now, most of the transmitting converters to allow lower frequency SSB units be used on VHF have been so complicated, that the converter costs more than the SSB generator! Here's a unit that will let any 20 meter SSB transmitter be used on two meters with a minimum of materials, time, and labor. The end result is most satisfying and will give you hours of pleasure without that darn QRM and lower frequency squabble!

The "Two for Two" consists of a simple 6EA8 oscillator generating 43.333 MHz in the triode section and multiplying that up to 130 MHz which is fed into the cathode of the 6360 mixer. A 14 MHz signal from the exciter is fed into the grids of the 6360 with a prewound 20 meter coil. This makes a very easy coil-winding job to construct the Two for Two. The coupling link in the coil can be moved to allow proper coupling for the amount of injection needed to drive the 6360 mixer-final.

The power supply can be built on a separate chassis, or on the back of the converter chassis, depending on the method and space of using the Two for Two. The reason for this is that you just may have room in your existing lower frequency transmitter to allow the mounting of the Two for Two on the back panel or on a lip inside the top cover. The power supply would then be remote. In any event the power supply is very simple. I used an old discarded television transformer and designed the supply to give me all of the voltages needed, including that always troublesome bias voltage. So many of the bias voltages in equipment built today have the battery supplies that always cause trouble with dead batteries and consequent loss of tubes. This one is a very simple, but yet tremendously effective supply that allows complete cut-off of the final during the receive periods via S1.

Construction of the unit is very simple and straightforward. The only item to watch during construction and layout is that you mount the 20 meter B & W input coil, L3 on top of the chassis and the final amplifier coil, L4 underneath in order to allow complete shielding between the input and output sections. This also allows for the output meter to be mounted on the front lip of the chassis along with the plate and load controls of the final. The grid capacitor, C1 is mounted on the back portion of the chassis with the shaft extending through the bottom of the chassis. This control need only be set once and forgotten, as any peaking of this section can be done with the exciter. If you desire to mount the converter in your present transmitter, merely build the rf section. This will make a small strip of chassis to mount inside the cabinet. The power supply is built on a separate chassis and remoted. S1, the bias control, is most convenient as part of the antenna coaxial relay. This can be wired to work with your SSB transmitter therefore making complete control of the two meter station just as it is on 20 meters, VOX and all!

The crystal socket can be mounted by soldering the pins of the socket directly to pin nine of the 6AE8 and a ground lug. L1 is mounted as close as possible to pin one as L2 is to pin six. This allows for the link from L2 to lay close to pin two of V2, 6360. Both rotor sections of C1 are connected directly to the coil, L3, all above the chassis. Two small grommets are mounted at each end of L3 in the top of the chassis and the 10 ohm resistors are wired from pins one and three up through the chassis to L3. The two 470 ohm resistors are mounted directly on the coil form, L3, as the bias center tap is fed through another small grommet to the power supply station. C2 is

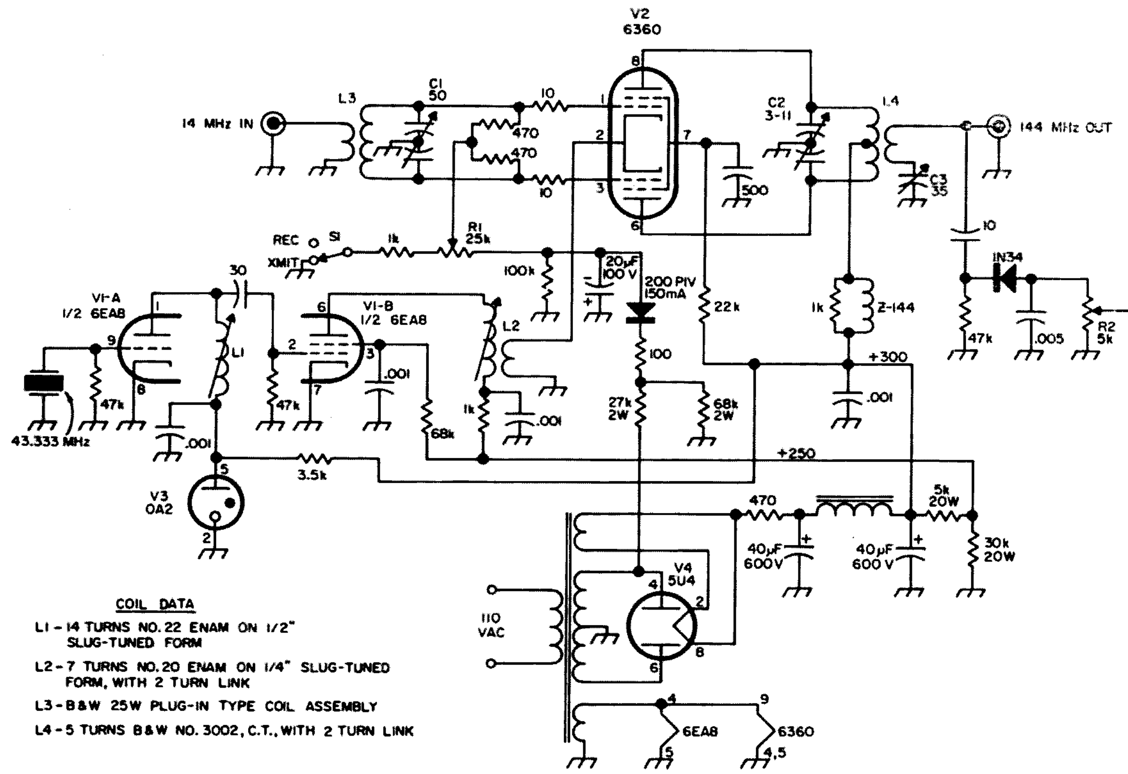


Fig. 1. K9EID's Two for Two two meter sideband mixer. This simple circuit converts 20 meter sideband energy to 144 MHz. It can be used alone for a few watts of SSB, or with an amplifier.

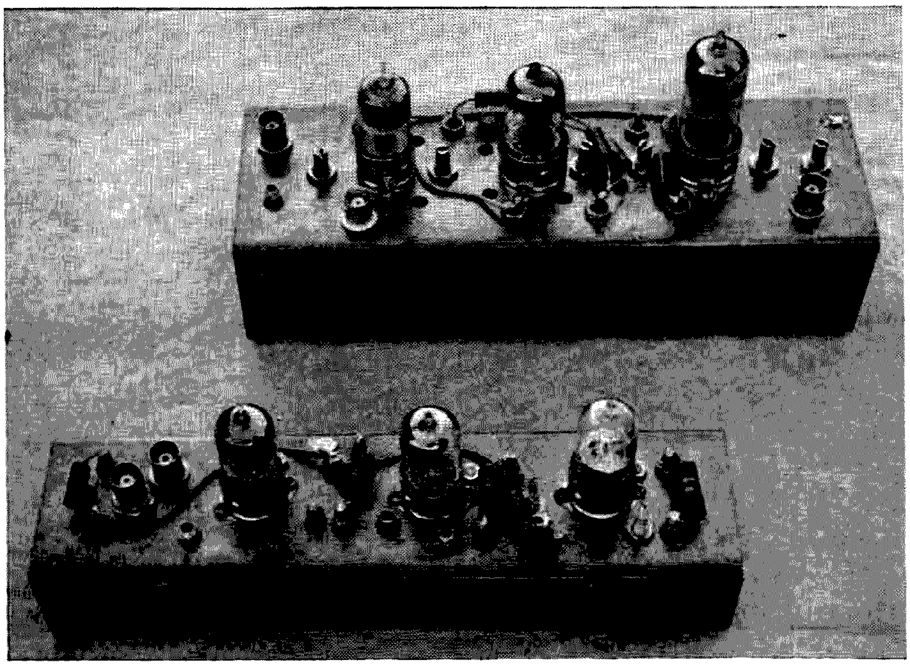
mounted on the front panel so that the stator sections can actually slip right into the pins six and eight of the 6360 tube socket. Solder these connections and then solder the coil form, L4 directly to the pins six and eight, also. C3 is mounted directly to the right of C2. All of the rf output meter components are mounted on the front panel. Be certain to observe the shunted resistor across the rf choke in the plate lead of the 6360. This is installed to prevent any self-oscillation of the rf choke and the final capacitor.

Upon completion of the construction, which should take only one good evening of your time, begin tune-up by first measuring the plate leads with all power off with a VTVM to check for any shorts or misconnections. After this is determined, apply filament voltage and wait for warm up. First measure the bias voltage at pin one or three of the 6360. S1 should be open, or in the receive position. The voltage here should read around −50 volts. Close S1 and while continuing to read this bias voltage, adjust R1 so that the bias reads about −22 volts. Now observe the color of the 6360 plates. They should not be red. If they are, adjust R1 until they show no trace of color; further checking will likely reveal that the plate and screen voltages are too high as a result of differences in the power supply components. Adjust the resistances so that the plate of the 6360 reads +280 to 300 volts and the screen +160 to 180 volts.

At this time it will be necessary to begin checking the oscillator with the grid dipper for output. Adjust L1 for maximum 43.333 MHz energy. Then adjust L2 for maximum 130 MHz energy. While using the dipper, adjust L4 and C2 to resonate at 144 MHz. Now apply 20 meter energy from the exciter and tune the plate and load control of the exciter. Adjust C1 for maximum grid drive to the 6360. The last adjustment will be to adjust the plate and load of the 6360 to your antenna system and set R2, meter shunt for mid scale reading with full carrier injected from the exciter. Don't forget that S1 must be in the transmit position in order to have any energy pass through the mixer and final of the Two for Two. The tube is completely cut off in the receiver mode.

This should complete your unit. A linear amplifier can be added for higher power, but is not needed for most two meter SSB communications. This unit runs a few watts PEP. With a fairly decent antenna system this signal can have the effectiveness of much higher power and will do quite nicely for those nightly contacts without all the muss and fuss, though you may need an amplifier with more tuned circuits if you have any TVI. Have fun!

. . . K9EID/8



Top view of the 432 MHz mixer (top) and local injection generator.

Del Crowell K6RIL
1674 Morgan Street
Mountain View, Cal.
Photos: Ken Hetchler

A Practical 432 MHz Transmitting Converter

This easy-to-build and not-too-expensive converter will put your 10 meter SSB, AM or CW transmitter on 70 cm.

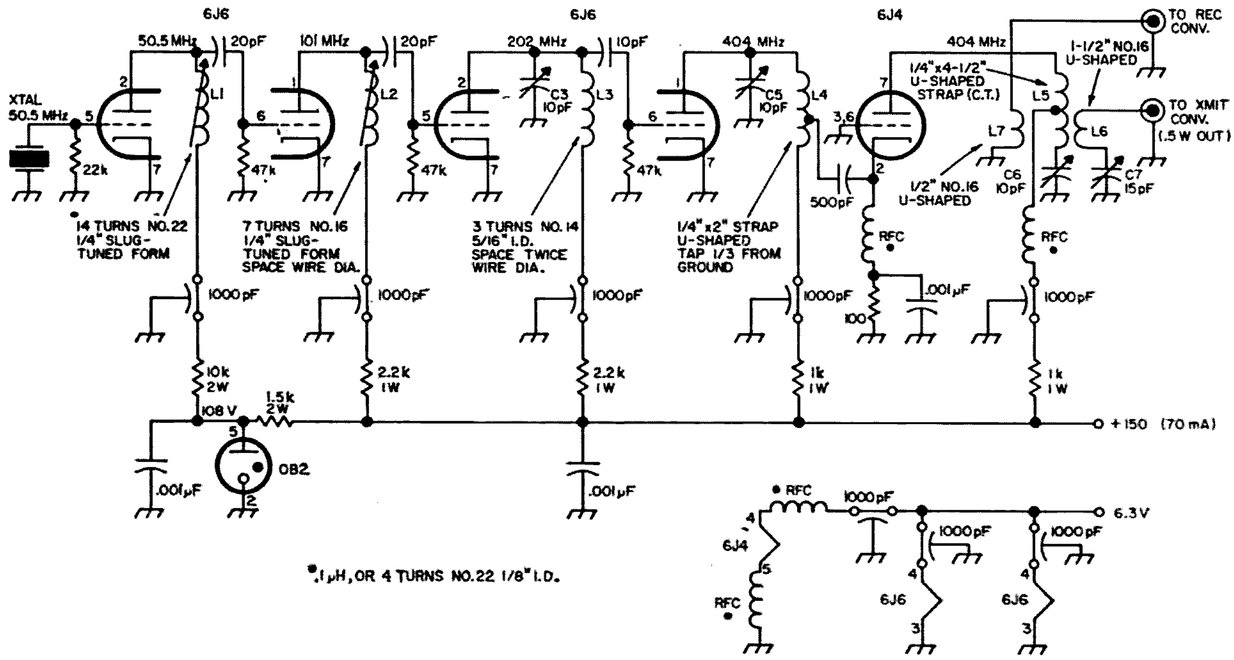


Fig. 1. Schematic of the local oscillator and multipliers for K6RIL's transmitting converter for 432 MHz. It puts out about a half watt on 404 MHz for local injection for the mixer.

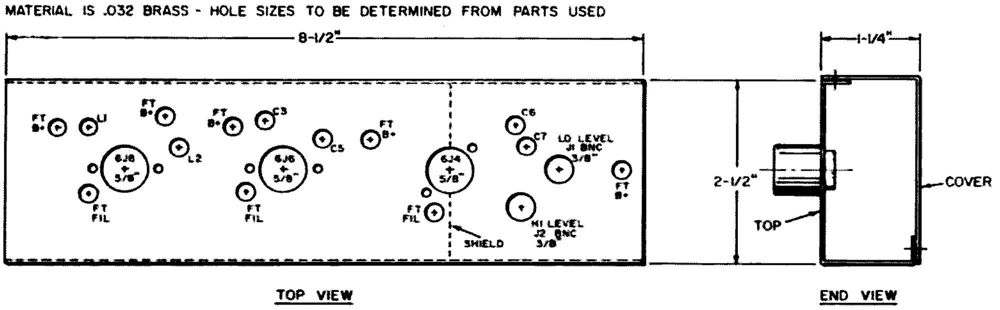


Fig. 2. Layout and construction of the local oscillator-multiplier shown in Fig. 1. ⅓ size.

Like to get on 432 MHz? Activity on the band is increasing every day, and the converter described in this article makes it possible for many hams to increase their frequency coverage and modes of transmission. This transmitting converter can be built at reasonable cost for operation on 432 MHz using CW, SSB, or AM. This is a linear system which reproduces the type of signal that is fed into it. The input frequency of 28 MHz was picked to reduce spurious signals and be compatible with most 10 meter transmitters. It will work with simple transmitters designed for only CW and AM, or with more elaborate units that cover all modes of trans-ission. The construction follows in two parts. The transmitting converter and local oscillator chain are built as separate units to allow ersatility, and for easier installation into hassis with higher power amplifiers.

Local oscillator chain

This oscillator and multiplier chain shown n **Figs. 1** and **2** uses inexpensive tubes. It tarts with one half of a 6J6 as a 50.5 MHz scillator. It operates at low plate voltage ith an 0B2 regulator for frequency stability. he three frequency doublers are nearly identical with exception of the tank circuits.

Last in the chain is a 6J4 grounded grid amplifier which delivers .5 watt at 404 MHz. This chain requires plus 150 V but can be used with plus 200 V and the output power will be approximately 1 watt. Good construction practice must be used as in most UHF circuits: direct connections, shielding, short leads, good bypassing, etc.

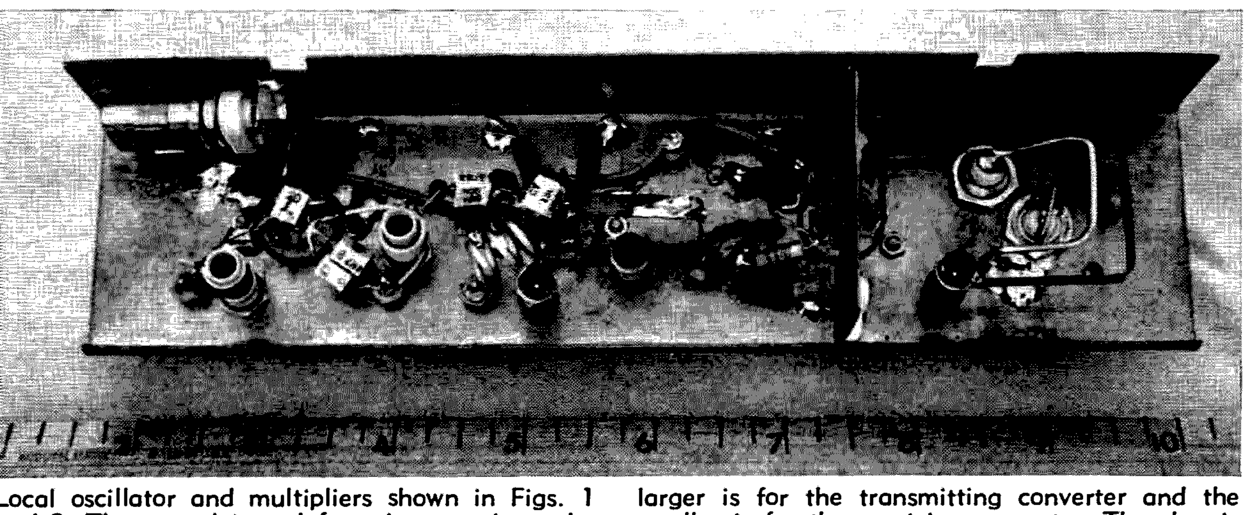
By building the oscillator and multiplier on a separate chassis the builder can use it for other experimental work. The unit is fixed frequency. It can be mounted in any position as it doesn't require constant adjustment.

Variable capacitors used are JFD but any good quality piston capacitor can be substituted. The largest expense is feed-through capacitors. These can be any coaxial type, threaded or solder-in, which are used in TV UHF tuners. These are easily broken, so use care in soldering them.

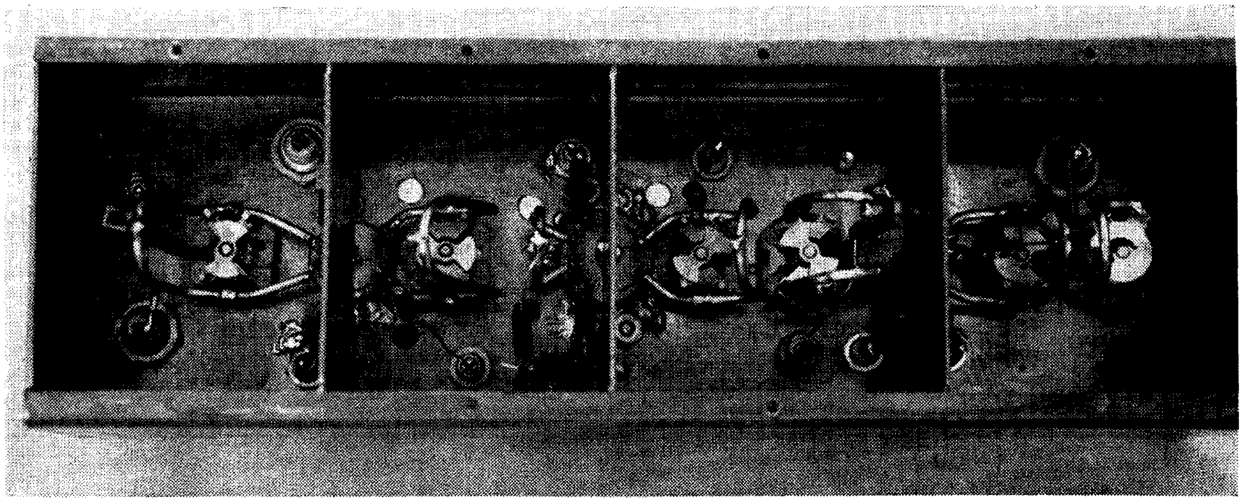
Since the local oscillator chain will be needed for adjusting the transmitting converter I recommend that you build it first.

The transmitting converter

The converter is shown in **Figs. 3** and **4.** The balanced mixer uses a 6J6 with the 404 MHz



ocal oscillator and multipliers shown in Figs. 1 d 2. The crystal is at left and output is at the ight. Notice that two output links are shown. The larger is for the transmitting converter and the smaller is for the receiving converter. The chassis is made of brass.



432 MHz transmitting converter. The left compartment is the input from the local oscillator and the 28 MHz exciter. The two center compartments are mixer plate and driver grid and driver plate and final grid. The output connector for about 5 watts at 432 MHz is at right.

local oscillator signal injected at the grids and up to 1 watt of 28 MHz signal injected into the cathode.

The driver stage uses a type 5656 tube operating class A with -3 to -4 volts fixed bias. This tube has an internal screen bypass capacitor of 15 pF and doesn't require external bypassing. The circuit is push-pull delivering about 2 watts at 432 MHz. This tube was built by Raytheon for use as class A and C amplifiers in UHF equipment for military and commercial aircraft. It is available through MARS or surplus outlets. Specifications can be found in ARRL Handbooks prior to 1955. The circuit could be rewired for a 6939 driver with good results.

A 6939 in the output stage does a fine job as a linear amplifier operating class AB2 with fixed bias of -6 to -8 volts. Plate current varies from 35 mA with no signal to 90 mA with full drive. It will deliver up to 5 watts output. All stages in the transmitting converter are operated as push-pull circuits. The tank coils are balanced quarter waves with the ex-

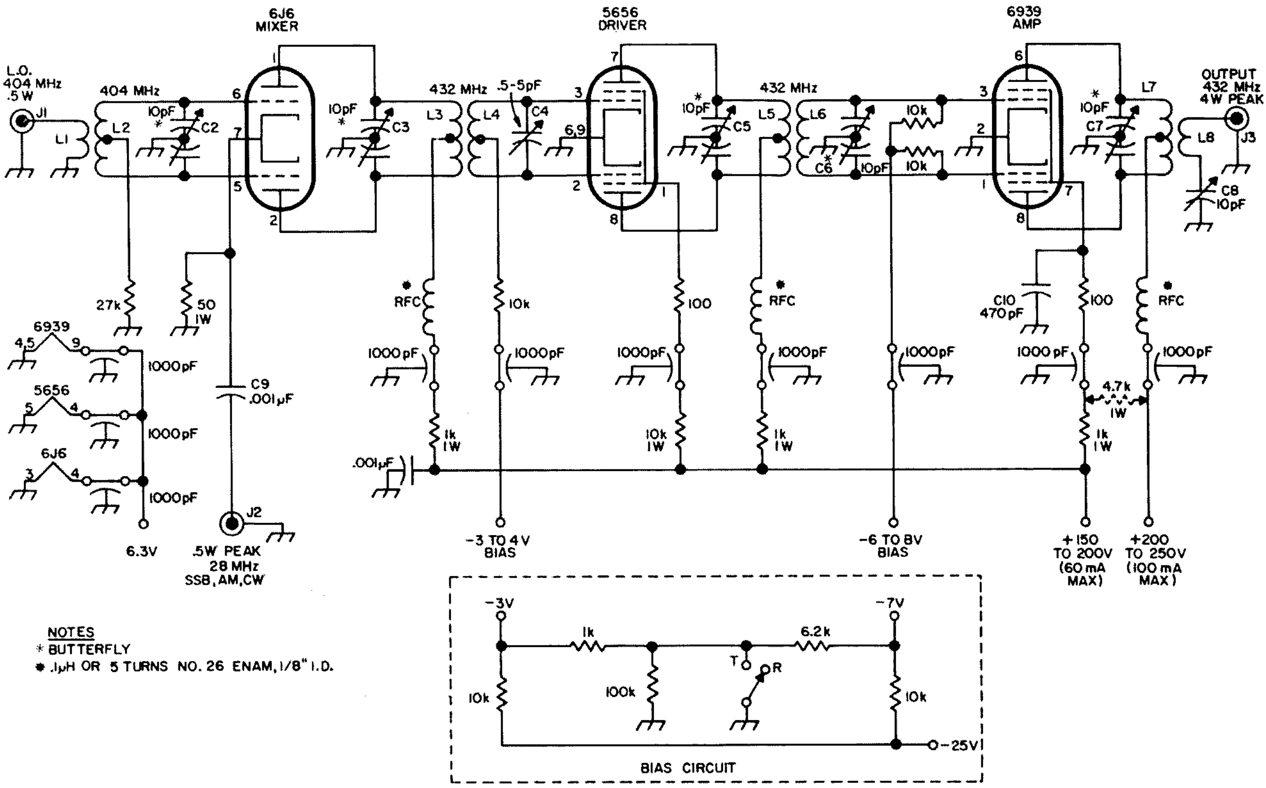
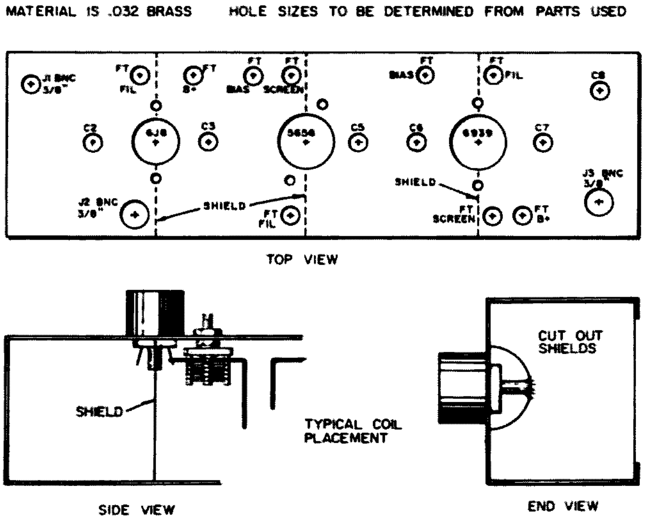


Fig. 3. Schematic of the mixer and linear amplifiers for K6RIL's transmitting converter. L6 should be shown as series-tuned half-wave lines with C6 at the end. See the photograph at the top of the page.



ALL COILS MADE WITH NO. 14 OR 16 TINNED OR SILVER WIRE
BEND INTO SHAPES SHOWN AT RIGHT

COIL	A	B	C
L1	3/4"	1/4"	1/2"
L2	1"	3/4"	9/16"
L3	1-1/4"	1"	9/16"
L4	3/4"	1/4"	1/2"
L5	1"	3/4"	9/16"
L6	1-3/4"		9/16"
L7	3/4"	1/4"	1/2"

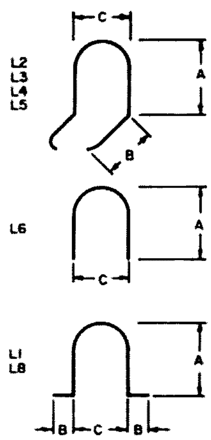


Fig. 4. Layout, construction and coil data for the transmitting mixer shown in Fig. 3. ⅓ size.

ception of the 6939 grid which uses half wave lines because of the high input capacitance. A quarter wave circuit would be too short to allow proper coupling. All lines are bent into a hair-pin shape. Most are bent at an angle as shown to conserve space and allow coupling between stages.

The butterfly capacitors used are Johnson 160-104 (9M11) and the tank is soldered along each side.

Construction

Shields are used across tube sockets for isolation and stability. The chassis parts were made from .035 inch brass, bent to form the shape required. Other shapes and styles may be used but the constructor must keep in mind that shielding and short lengths are necessary for good performance. All voltages are applied to tubes by feed-through capacitors and the dc circuitry is outside the chassis. Grounded tube pins are soldered directly to the chassis and shields are also soldered across the sockets. Brass gives the builder an opportunity to solder parts directly to the chassis as well as to conduct heat from tubes.

Adjustment and operation

After construction is completed, check for errors (wiring and assembly). A grid dip meter should be used to adjust the tuned circuits to frequency.

Next the dc voltages and local oscillator injection can be applied. Don't forget the bias for the tubes first. The transmitting converter current drain should be under 70 mA total with no 28 MHz drive. Feed in 28 MHz energy and adjust all the tank circuits for peak output at 432 MHz. Coupling is adjusted by bending the lines for maximum output and at the same time decreasing the 28 MHz level. After the circuits are all peaked, the output power should be greater than 4 watts with full 28 MHz drive. Both the 5656 and 6939 should indicate grid current. With the output connected to an antenna through a relay, and a receiving converter on, a small amount of noise will be noticed from the tubes which can be eliminated by switching the bias voltage to -22 volts for standby as shown in circuit diagram. This changes the bias voltage to cut both tubes off during standby and can be done by a pair of contacts on the antenna relay.

The exciter output power must be reduced to approximately .5 to 1 watt for driving the mixer input. There are many ways to accomplish this. **Fig. 5** shows the most common method.

This converter was constructed to allow mounting which will have provision for tuning from a front panel. I notice much of the equipment in magazines is without front panel controls. I prefer controls on all the equipment used at this station, as this makes for more flexible operation and everything can be located in racks.

Good luck. See you on 432 side band.

. . . K6RIL

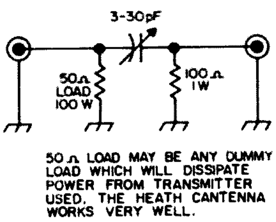
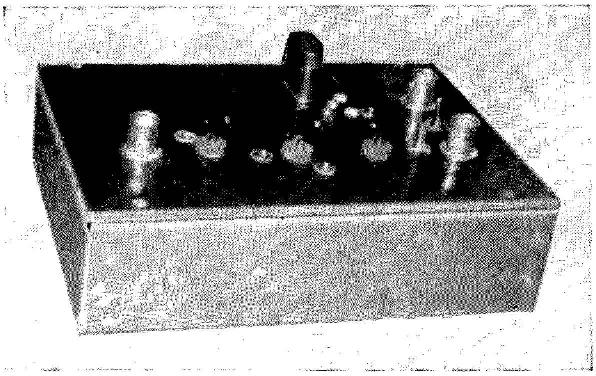


Fig. 5. Pad for reducing the power from a 28 MHz transmitter to about 1 W.



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A Low-Cost FET Two Meter Converter

This converter uses inexpensive field effect transistors as mixer rf amplifiers. It has a noise figure of less than 2.5 dB and very low cross modulation.

In the last year or two several bipolar transistors (conventional junction transistors) have been introduced which provide excellent VHF characteristics. A low noise VHF converter using these devices will be lower in cost, provide better performance, and use simpler circuits than a vacuum tube converter. Bipolar transistors costing only a dollar or two will produce noise figures as low as dB at 144 MHz. These devices share one serious shortcoming, however. They are very susceptible to cross modulation.

Cross modulation

One feature that all bipolar transistors and diodes have in common is a transfer function in which the current flow in a forward biased pn junction, e.g. the base-emitter junction of a transistor, is proportional to $e^{qv/kt}$, where q is the charge on an electron, k is Boltzmann's constant, v the applied voltage, and t the Absolute temperature. $e^{qv/kt}$ can be expanded into a series as

$$e^{qv/kt} = 1 + qv/kt + \frac{(qv/kt)^2}{2!} + \frac{(qv/kt)^3}{3!} + \ldots$$

The even order terms produce harmonics, even order combination frequencies, and dc terms. These products are usually not troublesome. It is the odd order terms which cause cross modulation.

At room temperature, 290°A, kt/q is equal to 26 millivolts. For voltages v greater than 26 mV the exponent qv/kt has a value greater than unity, it can be seen that the third order term increases rapidly when qv/kt is greater than unity. If v is composed of two voltages $E_a \sin\omega_1 t + E_b \sin\omega_2 t$ a little algebra will show that there will be a component at ω_1 with amplitude proportional to E_b and a component at ω_2 with amplitude proportional to E_a. This causes cross modulation.

The action of the fifth and higher order odd terms is similar to that of the third order term.

Therefore, we can conclude that with bipolar semiconductors applied voltages around 26 mV. will result in serious cross modulation. It is important to note cross modulation can occur not only in the first stage of a receiver, but in any stage where two or more large amplitude signals are present.

The designer of a receiver front end is faced with a serious problem. A highly selective filter which would prevent all but one signal from reaching a transistor or diode will be a lossy device. In order to have a noise figure as low as possible it is desirable to precede this filter with enough gain to make its effect on noise figure negligible. However, this gain may result iu the whole 2 meter band being amplified at once by 30 dB or more, and large voltages may easily result when strong signals

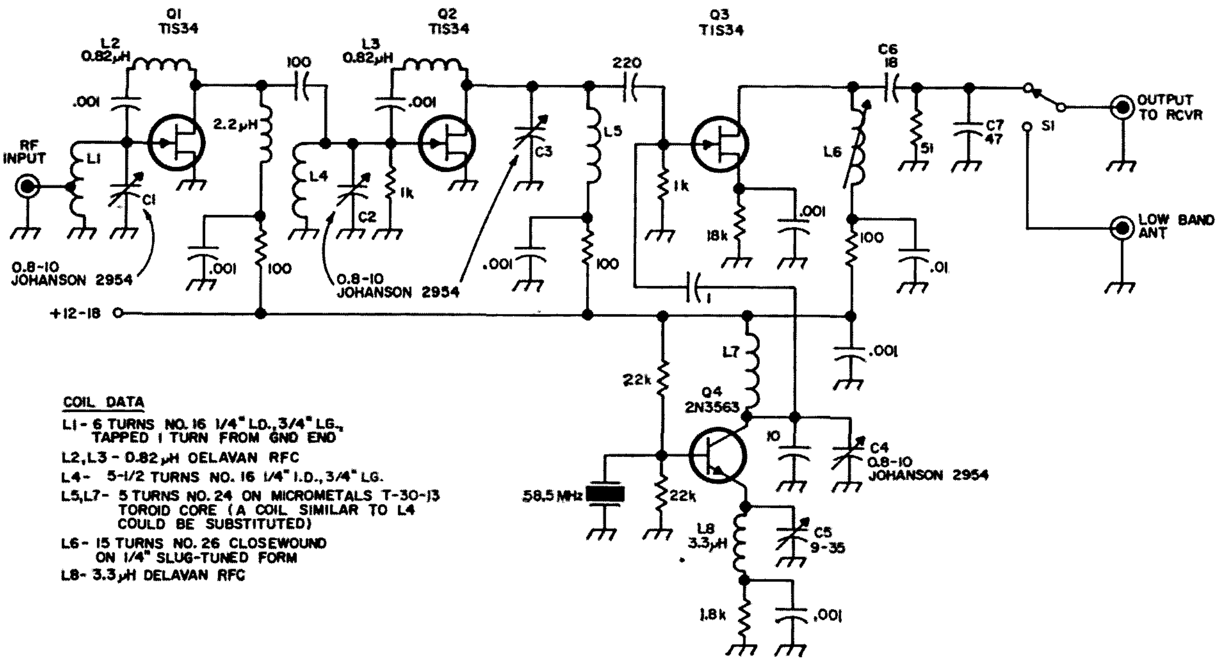


Fig. 1. Schematic of K6HMO's low-noise, low-cross modulation two meter converter using inexpensive field effect transistors (FET's). This converter can give a noise figure of under 2.5 dB, gain of 27 dB and very good rejection of cross modulation products.

are present. Some readers may have had trouble with FM and TV stations showing up in their transistor converters or receivers. It is usually insufficient front end selectivity and resultant cross modulation which are responsible.

The FET at VHF

The field effect transistor has an almost perfect square-law transfer function, i.e. odd order terms are almost nonexistent. The result is greatly improved cross modulation performance. In addition, recently introduced FETs are capable of very low noise performance in the VHF and UHF range. Noise figures as good as any vacuum tube or bipolar transistor are readily obtainable.

The device selected for this converter, the TIS34, is made by Texas Instruments and is encased in an economy plastic package. The price is $2.80. The TIS34 is very similar to the 2N3823—it appears to be the same chip—which has been available for some time for about $12. The data sheet for the 2N3823 is much more complete than the one for the TIS34 and it was used in the design of this converter.

Construction

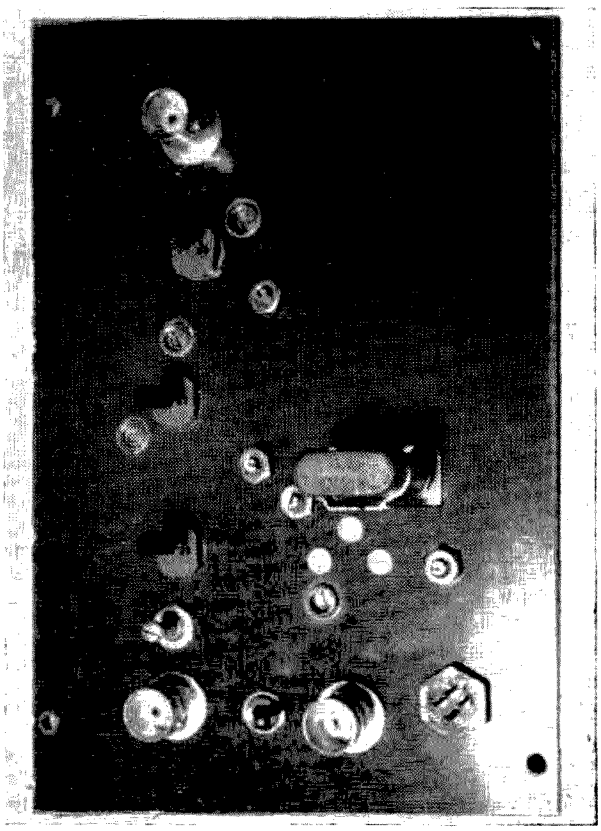
The FET converter shown in **Fig. 1** was constructed on a piece of printed circuit material cut 4x6 inches. The completed converter was mounted in an upside down 4x6x1½ inch aluminum.

The circuitry is very conventional and makes use of single-tuned transformers for impedance matching and to provide the required selectivity.

The noise figure test for the TIS34 specifies a source impedance of 1000 ohms. This is obtained with the tapped input inductor. The drain load impedance is simply the parallel combination of the real part of the FET input impedance and R1. The imaginary part of the input impedance is tuned out with L4 and C2. L2 is a standard rf choke used for neutralization by resonating with the drain-gate capacitance at 144 MHz. The second stage is essentially identical to the first. The rf amplifiers are simple, stable, and use very few components.

The design of the mixer was almost entirely empirical because of the lack of large signal data. The best compromise between noise figure and gain resulted when the FET was biased to a few hundred microamperes with the source resistor, (remember cathode bias) and then driven on with the local oscillator power. Better performance was obtained with the available local oscillator power when the local oscillator was introduced at the gate rather than at the source. The mixer output circuit is resonant at 28 MHz. The 51-ohm resistor terminates the receiver used with the converter and with L6, C6, and C7 determines the drain load impedance of Q3.

The local oscillator circuit is the same as the



Top view of the FET two meter converter.

Bottom view of the FET two meter converter.

one used by Frank Jones, W6AJF, in his converters shown in the June issue of 73. Briefly, L8 and C5 are resonant between the fundamental and the third overtone frequency. In this case L7 and C4 resonate at twice the third overtone frequency at 117 MHz. This results in an *if* frequency of 27 to 31 MHz. Other *if* frequencies could be used merely by selecting another crystal frequency and scaling the mixer output circuit to the desired frequency. For example, for 14 to 18 MHz use a 65 MHz crystal and double L6, C6, and C7.

The switch at the *if* output is used to switch

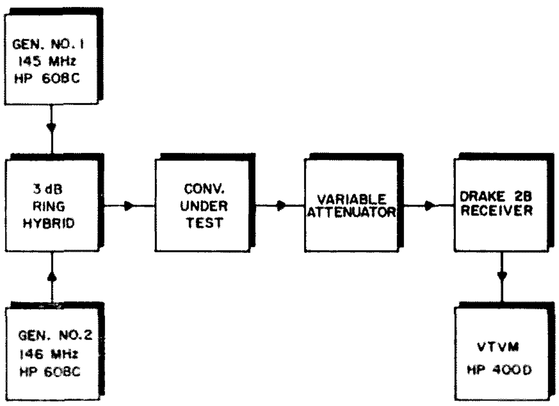


Fig. 2. Test setup used for cross modulation measurements.

the communications receiver between the converter and a low frequency antenna.

Performance

The completed converter has a noise figure of just under 2.5 dB measured on a Hewlett Packard Noise Figure Meter. The gain from 144 to 28 MHz was measured and found to be 27 dB. Cross modulation measurements were made in order to compare performance with a conventional bipolar transistor converter. The setup shown in **Fig. 2** was used for these measurements. The attenuator was included in order to assure that cross modulation observed was not produced in the communications receiver.

The converter-receiver combination was tuned to generator #1 at 145 MHz. Generator #1 was modulated 30% with a 1000-Hz tone, and the output level to the converter was 5 microvolts. The modulation on generator #1 was then turned off. Generator #2 was tuned to 146 MHz and modulated 30% with a 1000-Hz tone. The output level of generator #2 was then increased until the signal from generator #1 appeared to be modulated 1% (30 dB down on the VTVM). In ordinary use 1% represents a just detectable case of cross modulation.

This test was performed on both the con-

verter described here and another using bipolar transistors. The results are shown below along with other comparative measurements:

	Bipolar	FET
Noise Figure	3.1 dB	2.4 dB
Gain	24 dB	27 dB
Rf input for 1% cross mod.	0.5 mV	27 mV

As can be seen the FET lives up to the claims made for it. 27 mV at the input means about 1 volt at the gate of the mixer where the cross modulation should be occurring. This improved performance means that fellow down the street would have to increase his power 2916 times in order to produce the same amount of interference.

On the air tests at the author's shack have confirmed the improvement in cross modulation resistance. With the bipolar converter, the modulation of a local repeater could be heard on every other signal on the band. With the FET converter, no detectable cross modulation has been observed from the repeater or any other local station in several months of operation.

Miscellaneous

Power for the converter here is supplied by a transistor transmitter used with it. There is plenty of room, however, to build a power supply into the converter. A suitable power supply is shown in **Fig. 3.**

The trimmer capacitors used here are quite expensive. They sell for more than the FETs. Almost any other good quality type would be a suitable substitute. Small ceramic trimmers could be used at a considerable saving.

For those who have an especially acute cross modulation problem, and who are willing to experiment, even better cross modulation performance than that obtained with this converter could be obtained with the common gate configuration. The common gate configuration is similar to grounded grid in a vacuum tube. The noise figure will be about 0.5 dB higher and the gain a little lower, but because of the lower impedance levels the voltages will be lower and remember it is the voltage that leads to cross modulation.

. . . K6HMO

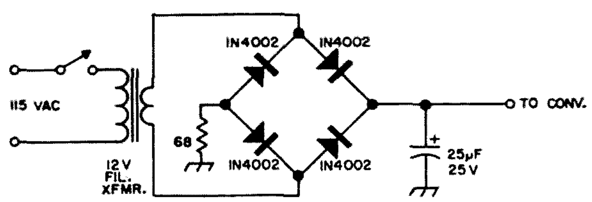


Fig. 3. Power supply suitable for use with the FET converter.

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Electronic Thermometer

Although this instrument is not exactly in the category of ham radio equipment, it is of an electronic design and an excellent project for the gadget builder. It's an electronic thermometer that may be used for a remote temperature reading with a scale from —50 degrees C to 250 degrees C. You can also calibrate it in Fahrenheit degrees.

Thermistors are thermally sensitive resistors whose primary function is to show a change in electrical resistance with a change in temperature. They are extremely sensitive to minute changes in temperature. A characteristic of thermistors is their wide range of negative or positive temperature coefficients. Because the resistance of a thermistor is a function of ambient temperature, thermistors can be effectively used in devices to measure or control temperature. The high resistance of a thermistor as compared to the resistance of long leads makes possible accurate temperature measurements from remote locations . . . such as your operating desk.

The bridge circuit shown in **Fig.** 1 may be used as a deflection device where the output can be calibrated directly in temperature. An 0-1 mA meter is used as the indicator. It is a GE Type D.0.91, Catalog No. 512x22. The thermistor is G.E. 3D-054- 100Ω plus or minus 1% at 25 degrees C. For calibration of the bridge circuit close the Null Switch (R1) and adjust the potentiometer for minimum reading. Open the Null Switch and adjust R2 (150Ω pot) for calibration. Switch can be miniature (or standard) push button type for temperature readings. This bridge circuit can also be used as a null type of bridge where the variable resistance is adjusted to null the bridge output and calibrated in terms of temperature. The five resistors in this circuit *must* be of the precision type for accuracy.

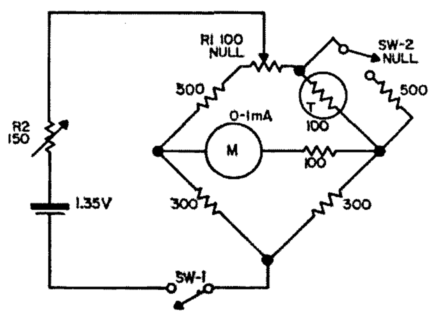

Fig. 1. Bridge type electronic thermometer. T is a GE thermistor as discussed in the text.

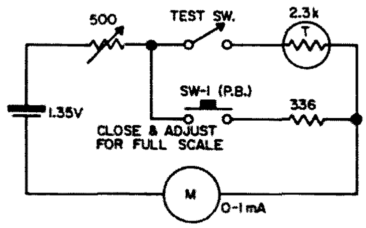

Fig. 2. Ohmeter type electronic thermometer. T is a thermistor. It's discussed in the text.

The ohmmeter type circuit as shown in **Fig.** 2 employs the GE Thermistor No. 2D-1119, 2.32 kΩ, plus or minus 1% at 25 degrees C. An 0-1 mA meter is used as the indicator. It is G.E. Type D.O. 91, Catalog No. 512x22. The 336Ω resistor must be one of precision type. For accuracy, components of best quality are recommended. The switch is a miniature or standard pushbutton type for temperature readings. If your dealer cannot supply you with the thermistor contact the General Electric Company, Magnetic Materials Section, P. O. Box 72, Edmore, Michigan. The price is $5.10 each.

Calibration of the meter is not difficult, although it takes a little time to calibrate the entire scale for normal use such as from —32 to 120 degrees F. A comparison thermometer of good quality is recommended.

It might be possible to use the thermistors which are incorporated in radiosondes and available at some surplus outlet. Inasmuch as these circuits are critical, considerable experimentation may be necessary to develop an accurate thermometer.

. . . K5ILG

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Controlled Avalanche Silicon Rectifiers

Another improvement in solid-state electronics

To explain what Controlled Avalanche Silicon Rectifiers are and why they are better than conventional silicon rectifiers, we must first review a few rectifier facts.

Over the past several years, silicon rectifiers have been gradually replacing vacuum-tube rectifiers in the power supplies for electronic equipment, because of their high efficiency, compactness, and convenience. However, as almost everyone who has used them has discovered, silicon rectifiers are not foolproof, primarily because of their severe voltage limitations.

Under controlled conditions, silicon rectifiers with voltage ratings well above 1000 volts can be made, but 400 to 600 volt units are much easier and less-expensive to make.

When a rectifier is forward biased—anode positive with respect to its cathode—it will pass its rated current with a very small voltage drop across it. But when the rectifier is reverse biased (hooked up backwards, as it were), little current will flow through it in the reverse direction until the voltage reaches a critical value. Above this critical peak inverse voltage (piv) or peak reverse voltage point, the reverse current increases very rapidly. "Avalanches," as the solid-state engineers say. The combination of high voltage and high current can destroy a rectifier in microseconds.

Actually, the normal voltages present in solid-state rectifier systems are only a minor problem, because they are easy to determine. The big trouble is with voltage transients inside or outside the power supply. For example, lightning strikes have produced instantaneous voltage peaks up to 5600 volts on regular 120 volt power lines. In addition, an arcing switch, a chattering relay, a blown fuse, a momentary power interruption, or the opening or closing a switch at a crucial point of the AC cycle can all generate transient voltage spikes ten times as great as the normal peak inverse voltages across the rectifiers and blow them instantly.

Surge arrestors connected to various parts of the power supply circuit can cut transient voltage spikes down to size. But the rub is that they may cost far more than the rectifiers they are supposed to protect. Furthermore, the only way to determine the proper values for many protective devices is to measure the transient voltages on a fast writing oscilloscope or a peak-reading voltmeter and experimentally adjust values to reduce the transients to the lowest practical value.

Unfortunately, transients have a nasty habit of appearing to be cured and then popping up worse than ever when least expected. As a result, several rectifiers may be destroyed before the transients are suppressed.

Now, at long last, we come to the Controlled-Avalanche Silicon Rectifier. Remember that the reverse current through a conventional silicon rectifier "avalanches" or increases very rapidly when the peak inverse voltage across the rectifier exceeds a critical breakover value and destroys the rectifier. Taking a critical look at the well-known fact that, while transient voltages in rectifier circuits frequently reach very high peak values, they are normally of very short duration and contain little energy, the rectifier engineers reasoned: *if we can cause the rectifier's back resistance to decrease even more rapidly than in a conventional silicon rectifier at the breakover point, the low resistance will present a virtual short circuit to the transient and will chop off the voltage spike before it can damage the rectifier.*

To achieve their aims, the rectifier engineers carefully refined the silicon from which the new rectifiers were to be manu-

factured so that its resistivity would be uniform throughout the entire slab, instead of being composed of layers of different resistivities as in less-carefully processed silicon. In addition, they doped the silicon very precisely while forming the rectifying junctons to make their interfaces as smooth and as free of voids as possible.

In operation, the controlled avalanche rectifier performs exactly as theory predicted it would. Under normal conditions, it performs just like a conventional silicon rectifier, but when a transient voltage peak comes along, the avalanche effect slices off the peak before it can injure the rectifier.

High Voltage Operation. Controlled Avalanche rectifiers have another advantage in high-voltage power supplies. As mentioned earlier, silicon and other solid-state rectifiers are strictly limited as to the amount of voltage they can withstand. Consequently, to rectify high voltages with them, it is necessary to connect a number of low-voltage units in series. But this procedure produces complications with ordinary silicon rectifiers.

Conventional rectifiers show considerable difference between units in their back resistance and in the length of time that it takes them to recover their back resistance when the applied AC voltage swings from positive to negative. For thee reasons, it is usually necessary to connect equalizing resistors and capacitors across each rectifier in the string when conventional silicon recitifiers are connected in series. 0.02 μf capacitors and 1000 ohms per volt of rectifier piv are typical values.

But the controlled characteristics of controlled avalanche rectifiers usually eliminates the need for equalizing resistors and capacitors in series circuits.

Selecting Controlled Avalanche Rectifiers. Several of the well-known rectifier manufacturers, such as *GE*, *RCA*, and *Sarkes Tarzian*, are manufacturing controlled avalanche rectifiers. *Sarkes Tarzian*, in fact, is now furnishing the controlled avalanche type of rectifiers under the same type numbers and prices as of their older rectifiers which did not have this feature. Some other manufacturers make both controlled avalanche and conventional silicon rectifiers, and still others make only the conventional type. You, therefore, must exercise a little care in your selection if you want the new controlled avalanche type.

One way to identify controlled avalanche rectifiers is to check piv's in your electronics parts catalogue. Two of them are listed for the controlled avalanche rectifiers. Use the lower figure for designing the power supply. The higher "non-repetitious" or transient piv is the point at which transient voltage spikes will be chopped off.

Incidentally, when conventional silicon rectifiers are replaced with controlled avalanche rectifiers, it is not necessary to remove any protective devices already installed in the power supply. Leave them in for an extra safety factor, because controlled avalanche rectifiers are not cure-alls for all rectifier ills. Extra-energy transients can still damage a controlled avalanche rectifier, if the rectifier is not conservatively chosen. But the important fact is that the odds go up in your favor when you use them. . . . W9EGQ

The Touch Keyer

This simple circuit allows key-type operation without a key. The operator just touches the grid and taps out the CW with his finger. When you touch the sensor plate, a small current is applied to the gate of the SCR from the battery B1. This turns on the SCR, which supplies half-wave power to relay RY1 to energize the relay. Diode CR1 provides a return path for the relay-induced voltage and is necessary to prevent 60 cycle relay chatter. The SCR triggers when a low level positive current is applied to the gate of the SCR and turns off as soon as the current is removed. The low battery voltage along with the use of an isolation transformer provides no hazard to the operator. . . . David Metzger K8GVK

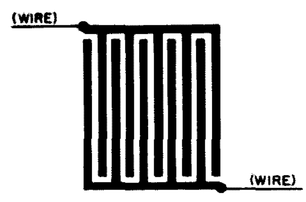


Fig. 2. The touch grid can be made from etched circuit board like this, or can simply be two wires.

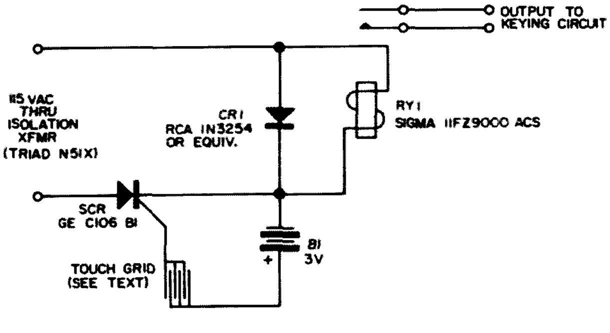
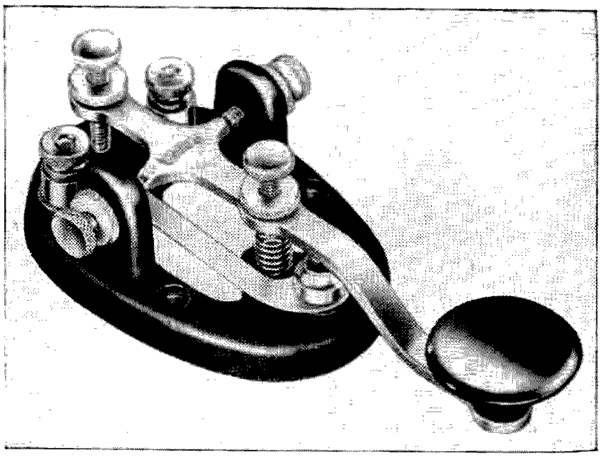


Fig. 1. Here's the ideal substitute for a key: Touching the touch plate with your finger turns on the silicon controlled rectifier (SCR), which throws the relay to key your transmitter.



The straight key is the basic CW instrument. This is E. F. Johnson's model 114-310.

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Look What's Happened to the Telegraph Key!

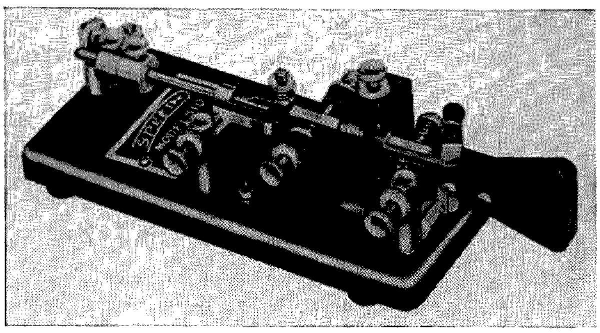
CW is not yet dead. As a matter of fact, if the current offerings of the telegraph key manufacturers are any indication, it may become as popular as single-sideband.

The traditional mechanical keys are still around and in a variety never available before. But the big new sound on the CW bands comes from the keyers—electronic devices using space-age circuits to make sending easy and more precise.

The electronic keyers require SPDT key action. So, for the first time in many years, the "Sideswiper" key is in the spotlight.

And there are keyers with features that result, strangely enough, from the popularity of voice-only SSB transceivers.

The new look in CW has brought forth a bewildering array of keys and keyers to suit the purposes of any CW operator. In this article we will describe the relative merits of the different keying methods and list the features of commercial keys and keyers.



A semi-automatic key by E. F. Johnson. Model 114-520.

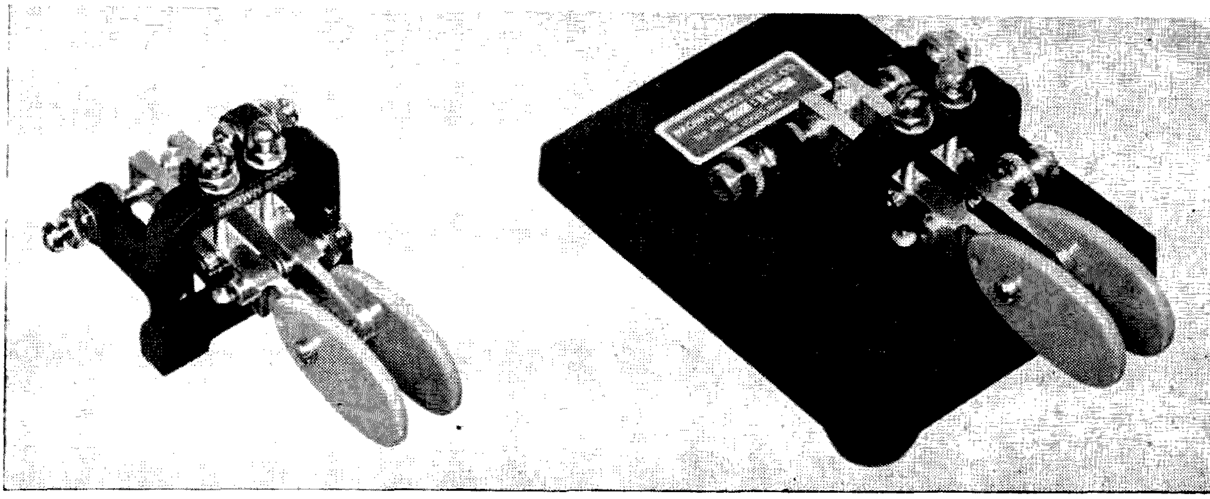
Straight keys

The time-honored straight key is universally present in ham shacks and commercial radio rooms. With its round black knob it hasn't changed much since before radio was born. Unless the FCC changes its mind about code exams it's likely to be around for a long time to come.

It's the only key recommended to the beginner for code practice and for operating on the novice bands. The amateur whose primary interest is in phone operation may never want anything more elaborate.

The E. F. Johnson Co. makes a complete line of straight keys ranging in price from \$2.40 to \$7.95. The lower priced keys are designed primarily for code practice. They have phenolic bases than *can* be cracked if screwed too tightly to the operating table. The more expensive models feature metal bases, smoother bearings and more precise adjustments. Keys are available with shorting switches (a feature important in wire telegraphy but not usually needed by the amateur radio operator) and in different decorative finishes.

The Brown Bros. model ST has a heavy square base that will not tilt under normal keying pressure. It is useful on a glass-topped desk where it would be difficult to screw down a conventional key.



Left. Brown Bros. model UTL sideswiper has tapped holes on front and bottom for mounting in custom electronic keyers. Right. For those who need a complete sideswiper, the UTL can be purchased mounted on a square base.

Semi-automatic keys

It's entirely possible to send CW at 30 wpm and above with a straight key. But it is difficult and soon becomes tiresome. Thus, for many years, operators have favored the "bug" or semi-automatic key. It makes a string of dots when the lever is pressed to the left. Dashes are made manually by moving the lever to the right. It is a vast improvement over the straight key for sending speeds above 15 wpm.

Although the semi-automatic key is substantially more expensive than the straight key, it stands out as a star performer in the fight against inflation. In 1925 the Vibroplex Co. advertised their "Bug" at $17. Forty years later their "Champion" model sells at $17.95. Other models with jeweled bearings, attractive finishes, and complete with cord and wedge range up to $33.95.

The wedge slips under the circuit closing switch of a straight key (if it has one) so that the semi-automatic key can be attached to the transmitter keying circuit without permanent wiring. It's useful to the commercial operator who takes his own key to work with him but is not generally used by amateurs.

The standard semi-automatic key is for right-handed operators but left-handed models are available.

Electronic keyers

The electronic keyer is the device that sits in the spotlight today. It's truly a product of the age of electronics.

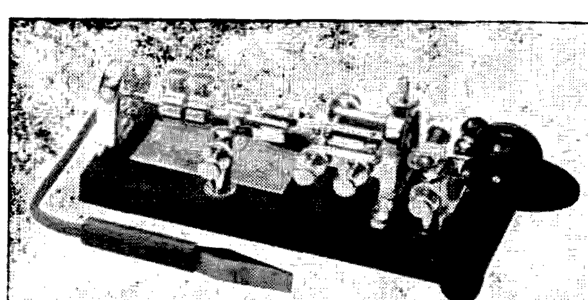
The multivibrators, gates, binary counters and other circuits that came into widespread use with the advent of Radar led to experiments with electronic keyers more than twenty years ago. In the past few years several commercial designs have appeared.

The electronic keyer uses a two-way lever. Press to the left and it makes a string of dots; press to the right and it makes a string of dashes. But that's not all. Just as a doughnut is not complete without a hole in the center, Morse code is not complete without proper spacing between the dots and dashes. Electronic keyers form the spaces with their "self-completing" action.

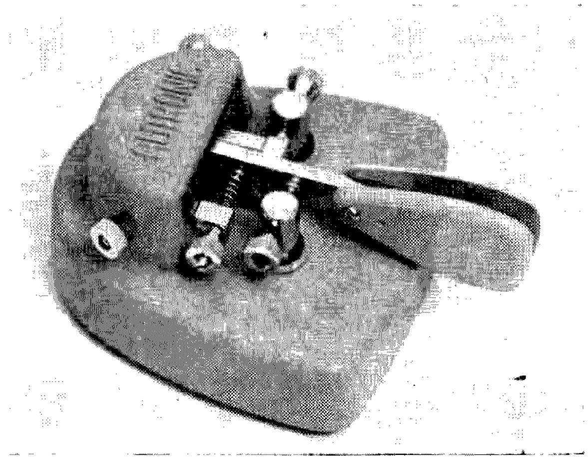
Here's how it works: Press the key to make a dash. Once the key has been lightly tapped the events to follow are temporarily out of the operator's control. The keyer *will* make a dash and then it *will* make a space. After the dash and the space are over the operator regains control and can call for the next dot or dash.

It's because of this "self-completing" feature that the first try at operating an electronic keyer can be a frightening experience. If the key is not pressed at the proper times the output is gibberish. But, once the technique is mastered, code spouts out of an electronic keyer with a machine-like precision that is pleasing to the ear. Dots, dashes and spaces are perfectly "weighted," that is, dots and spaces are exactly ⅓ as long as dashes.

Hallicrafters' model HA-1 at $79.95 is a typical keyer. It will operate at speeds from 10 to 65 wpm, has the self-completing feature



The Vibroplex "Blue Racer" is typical of the semi-automatic keys. The wedge, in foreground, connects to the station's straight key.



Electrophysics Corporation's "Autronic" key typifies the new generation of sideswipers.

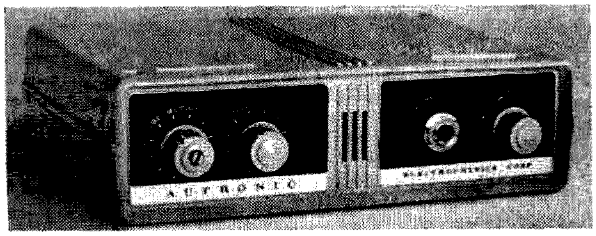
and includes an audio oscillator to monitor sending through headphones or on its self-contained speaker.

Electrophysics Corp. markets a transistorized keyer at $79.50 with similar specifications. The panel lettering has been rotated 45° so it is readable with the keyer horizontal or set on end.

Sideswipers

The keyers described above require a separate key for their operation. It must have a SPDT action, one contact for dots, another for dashes. Pioneer builders of electronic keys had to make their own. One method was to adjust a semi-automatic key to have continuous closure on the dot side. Another was to place two straight keys back-to-back.

Today, keys designed especially for electronic keyers are available. Electrophysics Corporation's "Autronic" key, $19.95, takes less



The "Autronic" key by Electrophysics Corp. Only 2" high it can be placed on end to save desk space. In its semi-automatic mode dashes are made manually. This mode is used "key down" for transmitter tuning.

space on the operating table than either a straight or semi-automatic key.

Brown Bros. model UTL, $10.95, is a key mechanism without a base for mounting on a home-brew keyer. Their interesting model CTL, $18.95, has a straight key and a sideswiper on a single base.

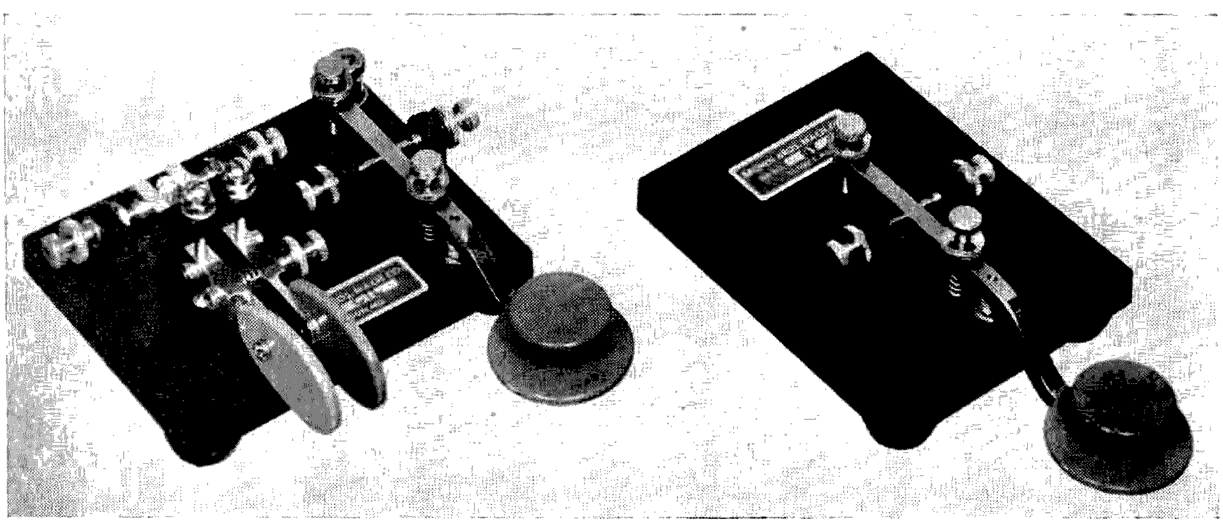
Both Vibroplex and Productive Tool make keys for electronic keyers that are similar in appearance and construction to semi-automatic keys.

SSB keyers

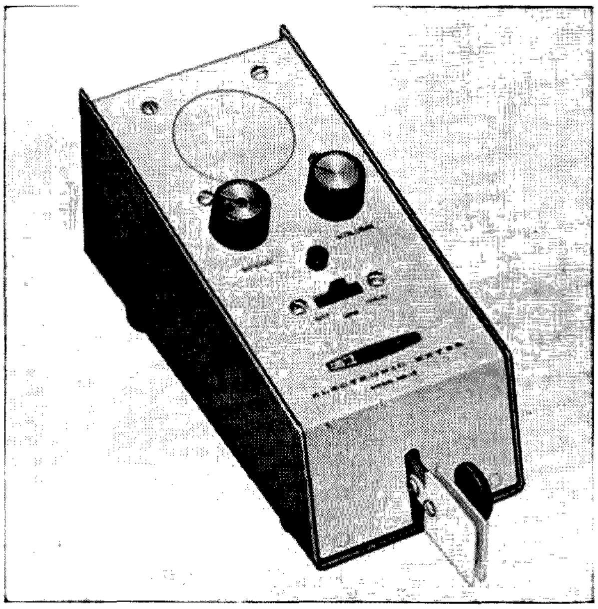
The keys and keyers described above are designed to key the transmitter carrier.

But what about the transmitters that don't have a carrier to key—SSB suppressed carrier transmitters? A few of the popular transceivers have provision for carrier injection so that they can be used for CW. Many do not.

Sideband Engineers has the answer to CW for the SSB operator in their "Codaptor." It works this way: Connect an audio oscillator to the microphone jack of a SSB transmitter and out comes a CW signal. Its frequency is above (USB) or below (LSB) the suppressed carrier



Left. The square base and rubber feet of this Brown Bros. key let it sit on the desk without screws. The double layer knob is known as the "Navy knob." Right. An unusual key by Brown Bros. On one base is a key for an electronic keyer and a standard straight key.



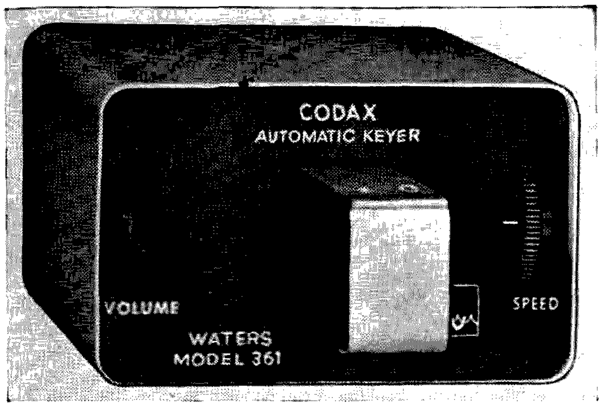
The Heathkit HD-10 has a paddle similar to those of semi-automatic keys. The "hold" position of the on-off switch is for transmitter tune-up.

frequency by the audio oscillator frequency. Key the audio oscillator and, presto, you're on CW.

The "Codaptor" also contains delay circuits that close the T-R relay of a transceiver before the keyed tone reaches the transmitter and keeps the relay closed, VOX fashion, for a time delay adjustable by a front panel control.

Integral electronic keyers

Two recently introduced keyers come with a built-in key mechanism. Waters Mfg. Co. offers a fully equipped package at $92.50. In one box it has a transistorized electronic keyer, a key, a tone oscillator for keying SSB transmitters and for monitoring, a mixer to combine



The built-in key of the Waters keyer requires only 20 grams pressure for operation. This keyer will operate for more than 400 hours on its self-contained batteries.

the station receiver output with the sidetone oscillator, and its own battery supply. This, at present, seems to be the Cadillac of keyers.

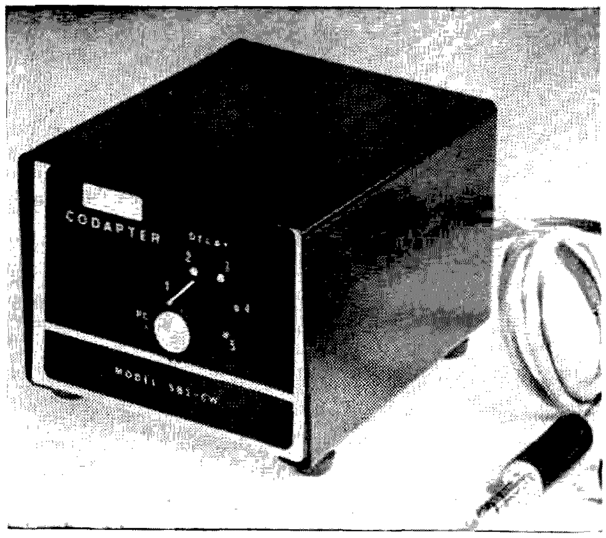
For the do-it-yourself constructor there is the Heath model HD-10. The kit, at $39.95, has an integral key and operates from 115 V ac. It will also run on an external 45 volt battery.

Most straight or semi-automatic keys will switch a good deal of power. Electronic keyers have specified maximum voltages, currents, and power that they will switch. They should always be operated within the manufacturer's ratings.

The switching ratings and other data on representative keys and keyers are included in the following table. Any of the manufacturers listed will be happy to provide further information.

. . . WA6CEZ

Hallicrafters model HA-1 keyer is based on a design by W9TO. The function switch provides two speed ranges and a "hold" position that keeps the transmitter on for tuning.



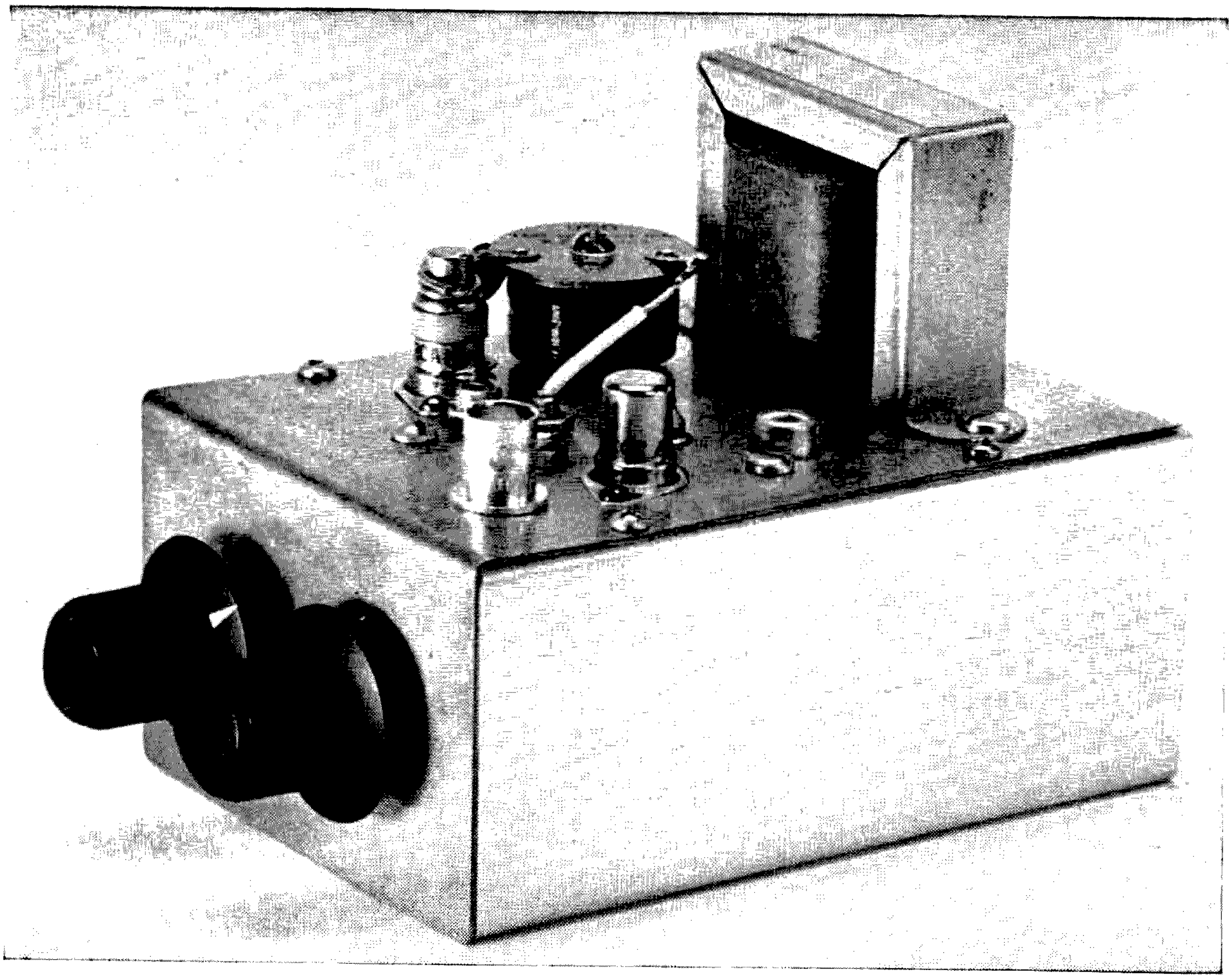
SBE's "Codaptor" allows an SSB transceiver to be keyed with a straight or semi-automatic key. After the key is opened, the transceiver T-R relay remains closed for a time selected by the front-panel "Delay" control.

Manufacturer	Model	Price	Type	Features
Ameco Equipment Corp. 178 Herricks Rd. Mineola, L.I., N.Y.	K-1	$ 1.00	Straight Key	Phenolic base.
	K-2	$ 1.45	Straight Key	Adjustable bearings.
	K-3	$ 2.35	Straight Key	Metal base.
	K-4	$ 3.00	Straight Key	Brass base. Shorting switch.
Brown Bros. Mach. Co. 5370 Southwest Ave. St. Louis 39, Mo.	ST	$ 6.95	Straight Key	Heavy base. For glass-top desks.
	UTL	$10.95	Sideswiper	Key only. For home-brew keyers.
	BTL	$14.95	Sideswiper	Same as UTL with heavy base.
	CTL	$18.95	Sideswiper Straight Key	Two keys on one base.
Electrophysics Corp. 898 West 18th St. Costa Mesa, Calif. 92627 "Autronic"	—	$19.95	Sideswiper	Compact. Use on glass-top desks.
	—	$79.50	Electronic Keyer	Transistorized, compact, for grid-block keying, switches 105 V @ 80 mA. High power switching transistors available.
Hallicrafters Fifth & Kostner Avenues Chicago 24, Ill.	HA-1	$79.95	Electronic Keyer	Mercury-wetted relay switches 5-amp 250 V 250-watts max.
Heath Company Benton Harbor, Mich. 49023 "Heathkit"	HD-10	$39.95	Electronic Keyer Kit	Transistorized, integral key, for grid block keying, switches negative 105 V @ 35 mA.
E. F. Johnson Co. Waseca, Minn.	114-300	$ 2.40	Straight Key	Phenolic base.
	114-301	$ 2.50	Straight Key	Phenolic base. Adjustable bearings.
	114-310	$ 3.50	Straight Key	Metal base. Takes wedge.
	114-310-2	$ 4.25	Straight Key	Shorting switch.
	114-311	$ 5.50	Straight Key	114-310 but chrome plated.
	114-311-3	$ 6.50	Straight Key	114-310-3 but chrome plated.
	114-100	$ 6.95	Straight Key	Brass base. Fully adjustable.
	114-100-3	$ 7.75	Straight Key	114-100 with shorting switch.
	114-520	$17.75	Semi-automatic	Circuit closing switch.
	114-500	$20.30	Semi-automatic	Fully adjustable. ⅛" contacts.
	115-501	$25.50	Semi-automatic	Fully adjustable. ¼" contacts.
Productive Tool & Mfg. Co., Inc. 9 Market Street Stamford, Conn.	"Nikey"	$17.95	Sideswiper	Dual lever, heavy base.
Sideband Engineers 317 Roebling Road South San Francisco, Calif.	"Codaptor"	$39.95	SSB Keyer	T-R relay control, adjustable VOX delay.
Waters Mfg. Inc. Wayland, Mass. "Codax"	361	$92.50	Electronic Keyer	Transistorized. Integral key. Switches 250 V dc, 1-amp, 15-watts max. Reed relay switch. Battery operated (batteries not supplied).
The Vibroplex Co., Inc. 833 Broadway New York 3, N.Y.	Vibro-Keyer	$17.95	Sideswiper	Heavy base. Fully adjustable.
	Champion	$17.95	Semi-automatic	Heavy base.
	Blue Racer	$22.45[1]	Semi-automatic	Compact size. Jewelled movement.
	Presentation	$33.95	Semi-automatic	Gold plated. Fully adjustable.

[1]—Cord and wedge at extra cost.

"The Bug" and "Vibroplex" are trade marks of the Vibroplex Co.

'Codax" is a trade mark of the Waters Mfg. Co.
"Heathkit" is a trademark of the Heath Co.



Don Nelson WB2EGZ
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A Poor Man's 220 MHz Receiver

Simplicity wins again with this easy-to-build receiver for local contacts on the 220 MHz band.

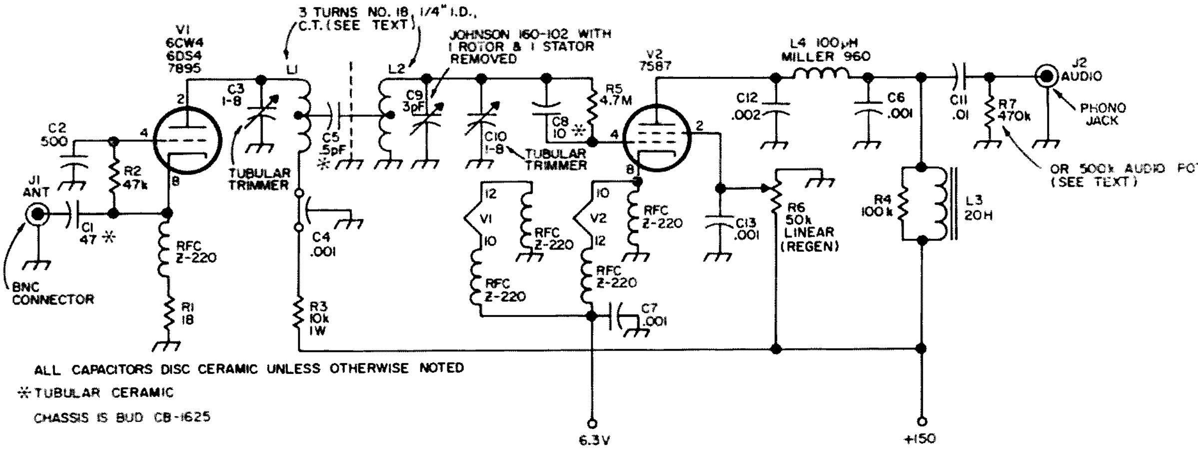
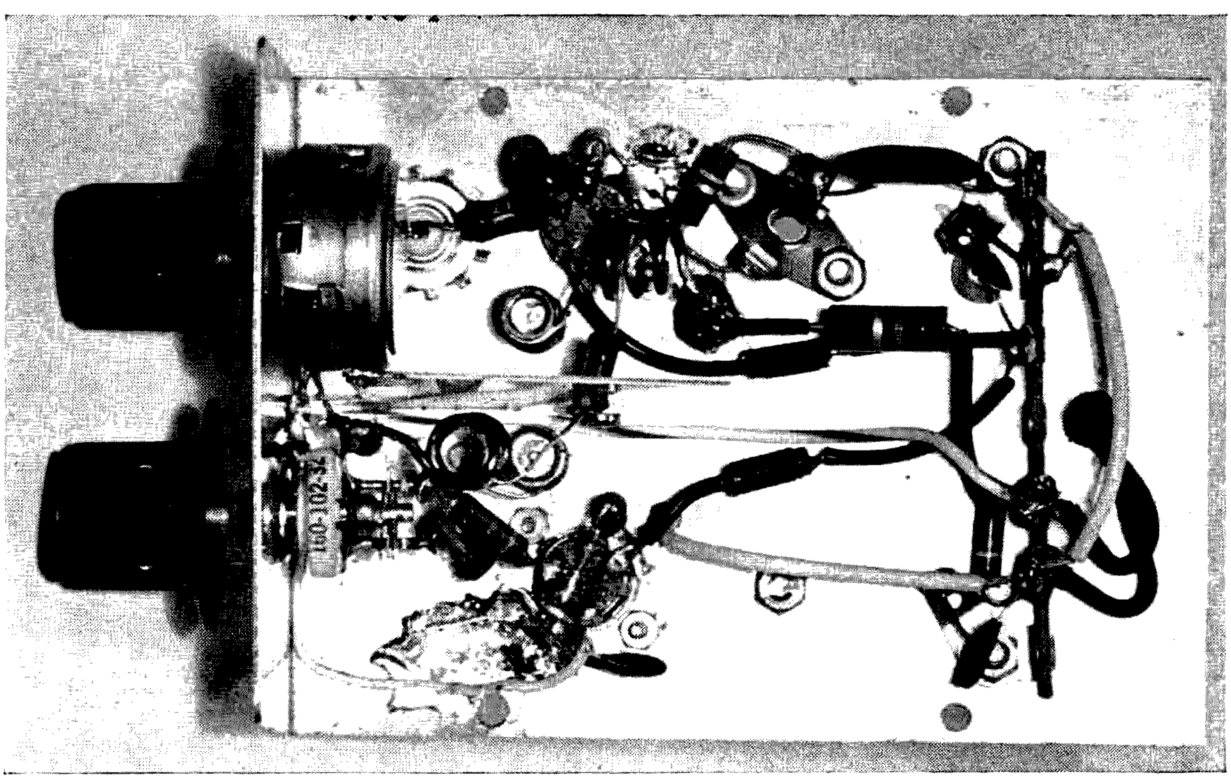


Fig. 1. A Poor Man's 220 MHz Receiver. This receiver is suitable for use with any simple audio amplifier or it may be integrated with the Poor Man's Transmitter in the August 73.

In the August 73, I left the realm of sophistication to describe a simple, low power 220 MHz transmitter which has enjoyed a remarkable performance record. Here is the companion receiver—a two tube superregenerative unit which may be constructed on the same chassis as the transmitter. Perhaps you would prefer to listen to 220 before building a transmitter. In that case, try this inexpensive receiver with any small audio amplifier.

The "superregen" has a few disadvantages on a crowded band, but crowds are rare on 220. On the east coast, DX'ers congregate near 220 MHz with local club activity at 220.5 MHz and 221.4 MHz. This receiver will easily separate the major frequencies. A grounded grid preamplifier serves to increase the sensitivity of the receiver, and minimizes detector radiation to the antenna. The grounded grid configuration has the advantage of minimizing overload problems if you live near a high power transmitter (such as TV or



Underside of the Poor Man's 220 MHz Receiver. As you can see, construction is very simple. This receiver was built as a unit, but it's easy to build the circuit into the transmitter.

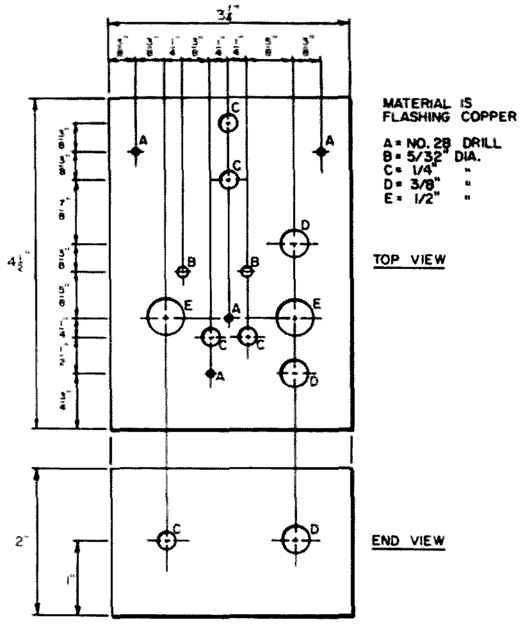


Fig. 2. Layout of the 220 MHz receiver. ⅓ size.

another 220 ham station). A Nuvistor tetrode detector from K6CJN in the June '63, 73 is still a fine performer at 220, giving very good selectivity.

Thin copper is recommended for chassis material if it is available, but this receiver was breadboarded on aluminum with satisfactory performance. The regeneration control was mounted on the front panel with the tuning control. One might prefer a volume control in front with the regen control on the rear. This is not critical so long as the screen bypass capacitor is located at the tube. An adapter must be made to use a ¼" knob with the tuning capacitor. This is most easily accomplished with a short piece of ¼" copper tubing. Careful work, short leads and good solder joints will pay dividends—Take your time!

With the tube heaters on, adjust C_3 to resonate L_1 at 221 MHz using a grid dip meter. Next, close the plates of C_9, the tuning capacitor, and tune C_{10} to resonate L_3 at 218 MHz. Values have been chosen to cover tuning from 218 to 228 MHz. Final adjustments should be made while receiving a weak signal.

Correct operation of a superregenerative receiver is dependent on the coupling of the tuning tank (L_2, C_9) to the preceeding stage. Superregeneration might be called partial oscillation—as such it is dependent on a correct amount of feedback.

The trick to making a useful superregenerative receiver is to keep the regeneration constant over the entire tuning range. This is done by selecting the correct point on the coil (L2) for the tap. The point farthest from ground at which regeneration is constant is the most desirable. This is a critical adjustment which makes the difference between a winner and "another old dog from a magazine." In this receiver it is practical to tap both L_1 and L_2 at the same approximate points, but small adjustments to perfection need only be made in the tap of L_2.

You may notice that the tuning of L_1 is changed by adjustment of C_9 because of the capacitive coupling between tanks. Such coupling in no way degrades the performance of the receiver and was found to be the most stable circuit of several circuits which were tried. Selectivity may be broadened by reducing the value of R_5 to 1 megohm. At the same time, sensitivity will be increased. Selection of R_5's value will vary with the amount of activity in your area, and to some degree, individual taste.

Happiness is listening to 220. Gene (WB2CVF) breadboarded the receiver and had it working in one Sunday. With slightly less talent applied to the second unit, the author's receiver was performing perfectly after three weeks of spare time and a little help from Gene. Not all was grim, however. A few bugs in the original design were exterminated in the second unit. Hopefully, you will find the project to be a pleasant task for several evenings. With the help of a good antenna, reliable 25 mile reception is no problem.

The author wishes to thank Steve Wojcik for the photography.

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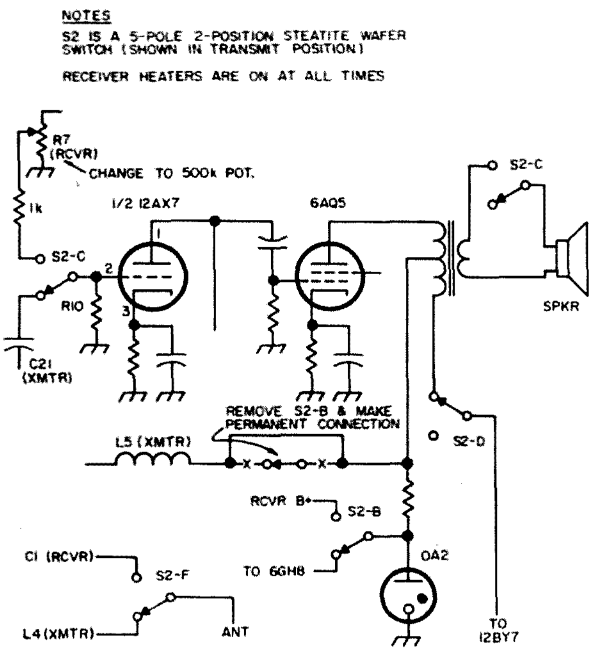
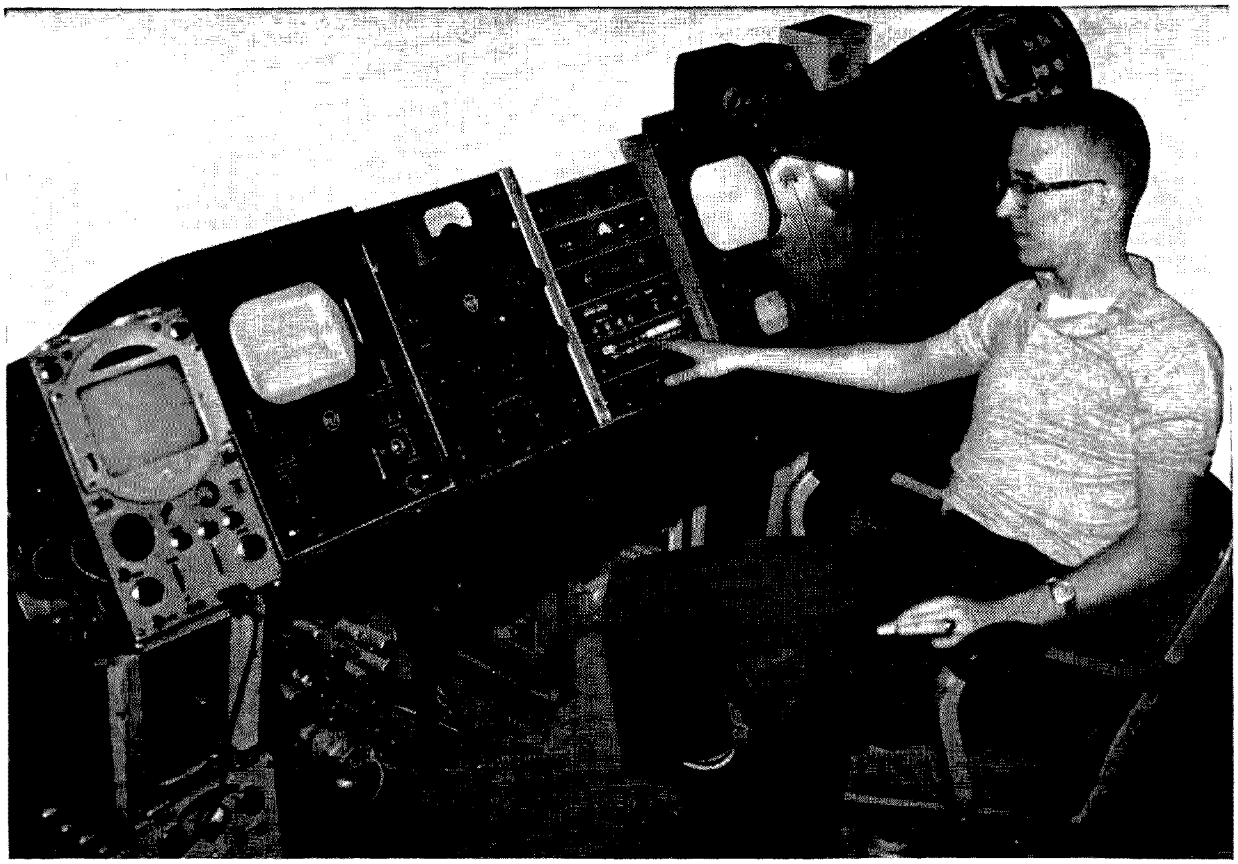


Fig. 3. Break-in schematic for operating the receiver with the Poor Man's 220 Transmitter.



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Amateur Television— Let's Get Started: Part I

Been thinking of getting on ham TV? This article explains how with all the information you need.

Many is the amateur who has started in amateur television only to be frustrated by poor results. There have been many articles over the years on individual systems,[1] but little information available to the amateur on setting up a complete system and making it work. In these two articles, the author attempts to relate his experiences with the hope of answering some of the many questions on the adjustment of the TV system.

First, let us review some of the terms used in television work.

Video: That portion of the television signal containing the picture information. (**Fig. 1**).
Synchronization or *sync:* That portion of the signal containing the timing pulses used to lock the monitor to the camera.
Blanking: That portion of the picture used to determine picture edges.
Set-up: The point of reference black. Setup is nominally 7.5 per cent of the 100 units alotted to the picture.
Composite television signal: A TV signal containing all of the above.

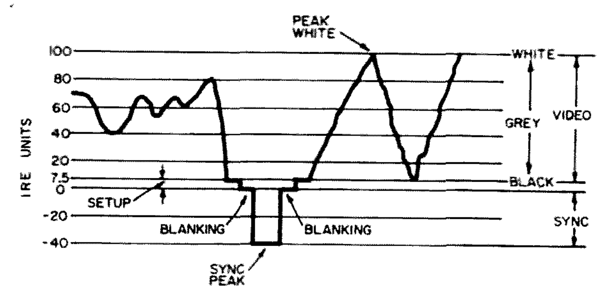

Fig. 1. Part of the standard TV signal. This drawing shows a horizontal sync pulse and video along with the standard IRE reference scale.

Resolution: The ability to detect detail. Horizontal resolution is measured by use of vertical lines and is determined by the number of vertical lines that can be seen in three fourths the picture width. Vertical resolution is measured with horizontal lines and is limited to a maximum of 525 due to the fact that 525 lines are the number sent by the scanning system. If interlace is not used, the resolution is limited to about 250 lines. This is because the two fields which are composed of every other horizontal line are not precisely locked together. Normally, the amateur does not use interlace so the amateur signal comes under the 250 line category.
Bandwidth: The total spectrum needed to send a television signal. Bandwidth is related to horizontal resolution by a factor of 80 lines per megahertz. More on this when we discuss modulators and modulated amplifiers.
Scan linearity: The ability to reproduce all parts of the picture in correct proportions. An example of poor vertical linearity is the stretched heads on a TV receiver caused by improper adjustment of the vertical linearity control. Most amateur cameras have no provisions for adjusting linearity per se, but do have height and width adjustments. These should be set for a width to height ratio of four to three.
Luminance linearity: The ability to reproduce all shades of grey from black to white correctly.
Ringing: An effect on the picture producing multiple images on either side of the main object; caused by overpeaked video amplifiers in the camera system. This is a high frequency distortion in the range above one megahertz.
Ghosting: Similar to ringing, except occurring only to the right side of the main object, and caused by improperly terminated coax lines, either video or rf, or by multipath reception when seen on an off-the-air signal.
Streaking: An effect producing a smear on the right side of an object extending for considerable distance, often to the end of the picture. A good example is often seen when white names are flashed on a relatively dark picture such as during the credits rolling by at the end of a commercial program. Caused by distortion at frequencies around 15-45 kHz and difficult to correct.
Smearing: An effect similar to streaking, but occurring over the whole picture giving the whole picture a muddy look. Also caused by low frequency distortion usually below 100 kHz. The effects of some of these distortions will be covered later.

Figs. 2 and 3 show the composite television signal at the vertical and horizontal rates respectively. Both traces are useful in signal analysis. The video, sync, set-up, and blanking are shown. Also note the scale used. This is the IRE[2] standard scale used to measure relative amplitudes of portions of the signal. The complete waveform equals 140 IRE units. Note that zero reference is at blanking. The sync occupies 40 units, set-up is 7.5 plus or minus 2.5 units and the video is nominally 92.5 units of information. The whole 140 units

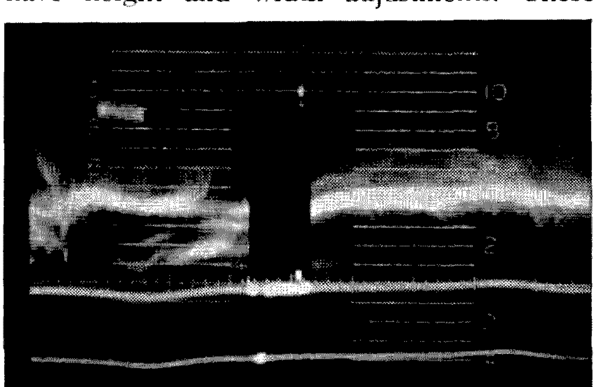

Fig. 2. Standard TV signal. Scope sweep 30 Hz amplitude one volt. The blank interval in the center is vertical blanking. Ten corresponds to 100 IRE units on the scale.

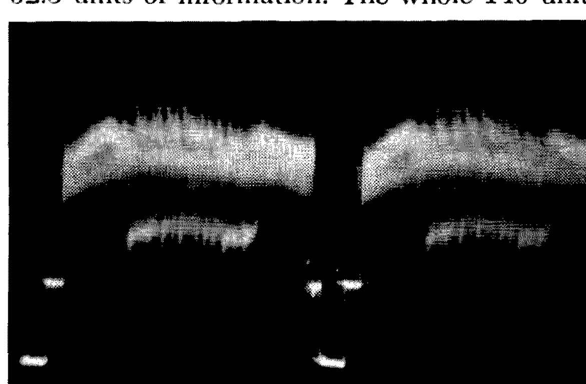

Fig. 3. Standard television signal-horizontal. Scope sweep 7875 Hz. Horizontal sync and blanking are clearly evident. Note also that the black parts of the picture extend down to almost plus 7.5 IRE units.

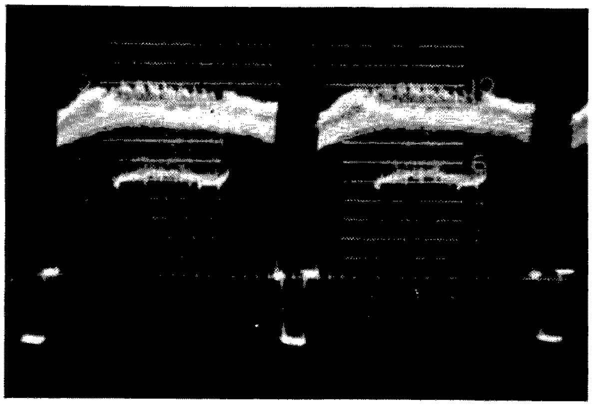

Fig. 4. High Set-up. Note blacks only extend down to plus 45 IRE units. The Camera video gain is too low. This results in a washed out picture.

correspond to one volt peak to peak. The blackest blacks occur at plus 7.5 units while the whitest whites occur at plus 100 units. Varying shades of grey occur between these limits. If a picture has no blacks, the peaks of the video would not extend down to plus 7.5. **Fig. 4** shows a video signal with such a condition. Here note the 'high set-up'. This is a normal signal if the picture corresponding to this scope trace had no blacks. If, upon knowing that the picture contained actual blacks, this scope pattern would indicate that video gain is too low and set-up is too high. Most amateur cameras have no provision for adjusting set-up, but do have provisions for adjusting gain. A camera with too little video gain will normally appear like **Fig. 4,** having the appearance of too high a set-up. The camera gain should be adjusted, when on a picture with whites and blacks such that the blackest blacks extend down to plus 7.5 IRE units. While it is desirable to keep the camera output at one volt, what is more important is the correct sync to video ratio of four to 9.25 as shown in **Figs. 2** and **3.** Since most cameras have no control over sync gain, the nominal 4 to 10 ratio should be maintained in preference to maintaining the output at one volt. Adjust the camera to obtain pictures as close as possible to **Figs. 1, 2,** and **3.**

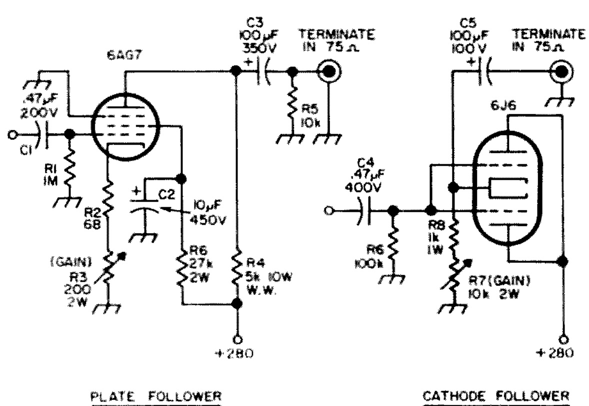

Fig. 5. Camera output stages

Test equipment

In order to make adjustments to the TV system, some test equipment is a must. We have already made reference to the scope. This is the most important item. Most any scope will do, but the higher priced wide-band units are best. In addition, acquire a good picture monitor (TV set). In order to view the picture before it goes through the transmitter, a means of tying the monitor and camera together must be employed. The biggest problem is polarity of the video. The standard method of running video around the shack is 'black negative' as shown on all the scope waveforms in this article. You should check your particular camera to see if the output is black negative and also to see if the output is low impedance, specifically 75 ohms. If both of these criteria are met, good. If not, **Fig. 5** shows the answer. Both circuits will make the camera low impedance, but the cathode follower should be used if the polarity of your high Z output camera is correct. If you find the blacks and sync positive going, use the plate follower circuit. This will invert the signal and provide the necessary low impedance output. Both of these circuits will enable you to use several hundred feet of camera cable.

Now that the camera has a low impedance output, additional equipment can be hung on as in **Fig. 6.** Note that the cable is terminated only once in 75 ohms at the end. All equipment including monitors and the modulator should be 'looped through' making one continuous line. Avoid tee connections. These will introduce ghosts even with the line matched. At K3ADS, the modulator has the 75 ohm termination built in so this unit is at the end of the line.

In order to make this low impedance signal useful in the TV set, a circuit is needed to bridge the camera output cable. **Fig. 7** shows a simple video amplifier that can be mounted in the TV set. Power can come from the set. Take the output and probe around in the video amplifiers to find a point where the picture

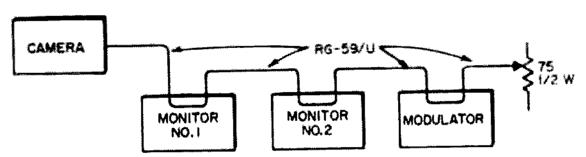

Fig. 6. 'Looping Thru' method of tying several equipments together on one video line.

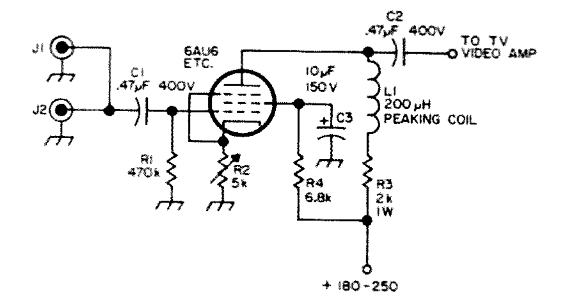

Fig. 7. TV set video preamp. Most TV sets need additional amplification for satisfactory results from one volt of video.

comes out in the correct polarity. Most of the older sets contain two video amplifier stages so it should be possible to find a point with sufficient gain to get a contrasty picture of the correct polarity. If not, use an additional stage to reverse the polarity. The plate resistors are of low value to improve frequency response and consequently, the gain of each stage is low. Now that the monitor is connected, the camera performance can be evaluated.

Test patterns and their uses

There are two popular test patterns available to the amateur. One is the familiar Indianhead pattern and the other the EIA[3] pattern, **Fig. 8**. The EIA pattern is preferred since it has ten shades of grey as compared to five on the Indianhead, but either are satisfactory. For those using one of the ATJ series cameras with a slide projector, these patterns are available as slides.[4]

Set up the camera facing the pattern and adjust the controls to obtain a picture. Adjust beam, target, focus, and gain for as good a picture as possible and then check to see that the camera 'sees' the complete pattern *exactly.* Adjust the camera height and width for the proper four to three aspect ratio as seen on a *properly adjusted monitor.* The monitor can

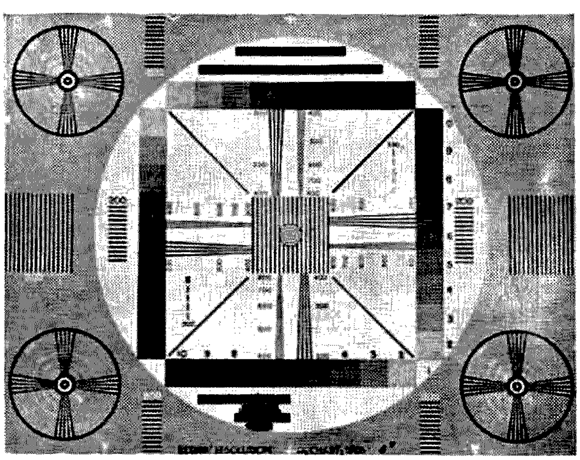

Fig. 8. EIA test pattern

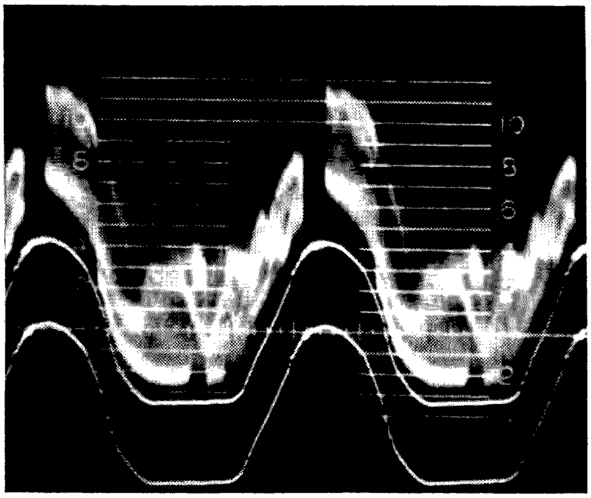

Fig. 9. 60 Hz hum scope at 30 Hz sweep. 120 Hz hum will have twice as many alternations. This amount is severe. Any hum over 10 IRE units is objectionable with levels over 40 IRE units destroying the picture.

be set correctly by getting up *early* one morning and using the test pattern transmitted by a local commercial station. If the monitor cannot be adjusted for a perfect pattern, remember the error and adjust the camera for a pattern similar to that seen from the commercial station. This way, the scanning error often present in TV sets can be compensated for.

On the test pattern, the horizontal and vertical wedges are calibrated directly in lines of resolution. It should be possible to obtain a horizontal resolution of from 200 lines on the ATJ series iconoscopes to 300 to 500 lines resolution on live vidicon cameras. On vertical resolution, the patterns will seem to come alive on the horizontal wedges. This pattern, called moiré is caused by the convergence of the wedges being nearly parallel to the scanning lines. This is an optical effect and should be ignored.

Other troubles

Fig. 9 shows the effect of hum. This is best observed with the scope looking at the vertical information. The ripples appear on the waveform monitor while horizontal bars appear on the picture monitor. In severe cases, the picture will gyrate with the hum. One black and one white bar indicate 60 Hz hum,

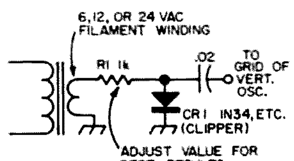

Fig. 10. Vertical oscillator line lock circuit.

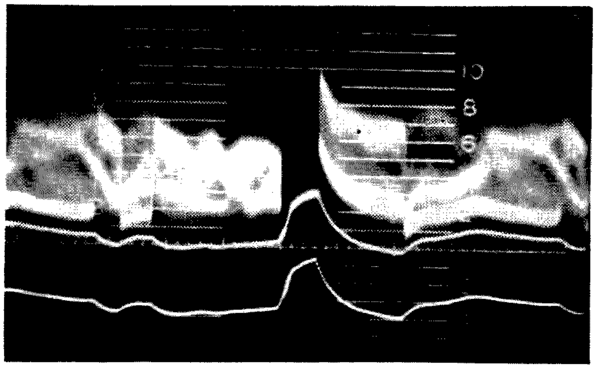

Fig. 11. Clamping failure. In amateur equipment, usually caused by defective coupling capacitors.

while two pairs indicate 120 Hz trouble. The former is caused by poor grounds between the camera, monitor, modulator, and other equipment. Also this hum can be caused by heater to cathode shorts in video amplifiers or by defective power supplies using half wave rectification. 120 Hz hum is always caused by defective full wave power supplies. Use plenty of filtering. 80 to 100 μF capacitors should be used whenever possible. To further minimize this effect, be sure the vertical oscillator in the camera is locked to the power line. **Fig. 10** shows a simple circuit which can be used.

Another problem occurring often is distorted vertical blanking as shown in **Fig. 11.** This is often caused by defective coupling capacitors in video amplifiers such as C3 in **Fig. 5.** Bad tubes also can cause this defect. Use the scope here to locate the defective stage by starting at the output and working back.

Most amateur cameras use free running horizontal oscillators. In order to get this oscillator close to commercial standards, lock in a commercial signal on the monitor, then switch to the local signal. If the horizontal oscillator in the receiver goes out of sync, adjust the horizontal oscillator in the camera until the picture stays locked in when switching back and forth between the commercial station and the local signal.

The off-the-air receiver

In order to check the operation of the TV transmitter when it is completed and to view the signals of other ATV stations, a 440 MHz receiver is needed. As a starter a modified UHF-TV converter can be used. Avoid modifying all-channel receivers. While these work fine for UHF TV, they do not have built in trimmer capacitors in most cases, making tracking difficult and almost impossible after conversion. Whatever converter you use, be sure it has an *if* amplifier. If transistorized, care must be taken to insure the rf from your own transmitter does not burn out the transistors in the converter.[5]

A popular converter for ATV is a modified Blonder-Tongue BTU-2 series. These use low noise diodes and 6ER5 frame grid tubes in *if*. A method of conversion suggested by K3KFL is to solder small two-turn gimmicks across the oscillator and preselector trimmer piston capacitors. Use number 20 plastic coated hookup wire for this. On late model Blonder Tongue units, the trimmer on the oscillator has been eliminated. In these units, remove the cover over the 6AF4A tube socket and solder the gimmick across the one already under the cover. Using a weak UHF-TV station, UHF signal generator, or regular 432 MHz amateur station, adjust the oscillator to cover from about 435 MHz up and *carefully* adjust the preselectors for best signal to noise. In addition to the above types of stations, radar-like signals and two way communications stations may be heard. If these are steady, they may be used for alignment. With care, the converter will still have high gain and good tracking up thru channel 50 or 60 and can still be used for UHF-TV reception.

When the system is completed and satisfactory pictures are being sent and received, then it is time to think of a good low-noise and, in this age, transistorized converter for 440. However adequate results can be had with a UHF converter and I suggest leaving the high sensitivity converter a project until after completion of the transmitter. Good rf amplifiers make an improvement over the UHF converter but because of the wide bandwidth of the TV receiver, the improvement is not as drastic as that observed on a phone signal.

Nexth month, we'll cover modulators, the modulated amplifier, and antenna systems. Meanwhile dig out the camera again. See you on 440.

. . . K3ADS

1. Kaiser, "A UHF Television Transmitter", *CQ*, April 1962.
   Daskam, "¾ Meter TV", *73*, Match 1964.
   Kennedy-Colby, "The ARC 26 TV Transmitter", *73*, June 1963.
   Hutton, "Amateur TV Transmitter", *73*, March, 1963.
   Taylor, "NSTC Signal for Ham TV", *73*, January 1963.
   Haines, "What's A Vidicon", *73*, Sept. 1962.
2. IRE Scale (IEEE) IRE Standard 23.S1, and the recommendations of the Joint Committee of TV Broadcasters and Manufacturers for Coordination of Video Levels.
3. EIA-Electronic Industries Association. Standard Test Pattern adopted in 1956.
4. Test patterns are available from Denson Electronics, Rockville, Conn.
5. Jones, "432 MHz Transistor Converter", *73*, June 1966.
   Reference: *Television Signal Analysis.* Second Edition, American Telephone and Telegraph Company, Long Lines Department 1963.

E. R. Davisson K9VXL
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Greenwood, Indiana

The Multical

A many-use, many-frequency crystal calibrator.

What is the "Multical"? As the name implies, "multi" would suggest several uses, and "cal" might infer a calibrator of some sort.

Well, that's right, but there is slightly more significance to the name. "Multi" is also a short form term used to describe flip-flop circuits known as multivibrators.

By combining the basic characteristics of a free-running multivibrator (astable) with crystal control, you have a simple, stable, virtually-insensitive-to-temperature-changes, crystal calibrator for that receiver you have been wondering about.

The circuit uses no inductors and depends upon the crystal for the proper feedback for oscillations. Temperature stability is partially due to the absence of capacitors.

Transistor stage Q_2 operates with unity gain, whereas transistor Q_1 operates at considerably more gain. Both stages are operating as feedback amplifiers. The harmonic generator diode D_1 is a 1N128. Any general purpose diode may be used.

By using the multivibrator circuit, the waveform obtained is comparatively rich in harmonics and could be used without any further refinements. However, to insure useful harmonics through 30 MHz starting from a 100 kHz crystal, a harmonic generator consisting of R_6 and D_1 shown in **Fig. 1** was added. The capacitors C_1 and C_2 are used strictly for coupling and have no effect on frequency stability.

Crystals from 100 kHz up to 1 MHz may be used in the Multical with no changes. The circuit will oscillate from voltages as low as 2 volts and can be operated safely from voltages as high as 20 volts. This wide range of voltage operation allows the source to be obtained from virtually any place.

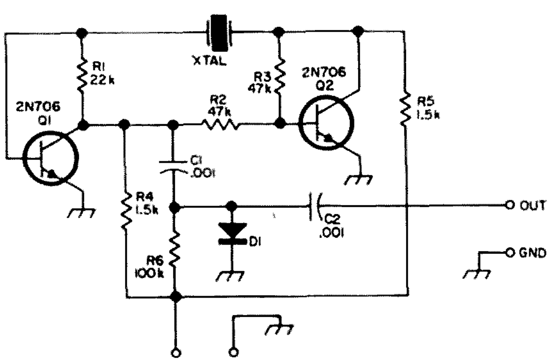

Fig. 1. Schematic of the Multical.

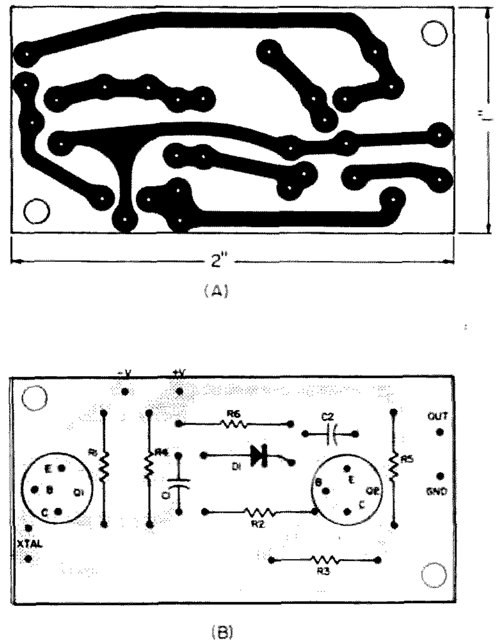

Fig. 2. Suggested printed circuit board layout for the Multical. A gives the copper side, B the component side. A board for the Multical is available for $1 from the Harris Company, 56 E. Main Street, Torrington, Conn.

Output from the calibrator may be fed directly into the receiver's input, or may be coupled to a short whip antenna. With a whip antenna, close coupling to the receiver's input may be required at higher frequencies. (Especially at the lower voltage levels.)

For the more ambitious builders, **Fig. 2** shows the printed circuit board layout for the Multical. Due to its small physical size (1" x 2"), room can probably be found even in the most compact of receivers. **Fig. 2A** shows the foil side, and **2B** shows the parts placement.

So the next time you wonder about the accuracy of your receiver calibration, give this simple circuit a try and you'll know for sure.

. . . K9VXL

Bill Reynolds K2ZEL
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Latham, N.Y. 12110

Connectors for Those Surplus Coaxial Tubes

"Tubes I have, sockets I do not have," and they want too much money for them. Also many of the sockets available in surplus do not have the built-in by-pass connectors. My problem came up when I wanted to make use of some 4X150A, 2C39A, and 2C40 type tubes for vhf-uhf amplifiers and needed connectors to attach to the external electrodes and sheet by-pass capacitors. As I began work on the projects, I remembered an article by WB6AOW[1] and tried my hand at making the connectors as he suggested. I had trouble getting the finger stock to stay in place as I added them around the ring. I would get one positioned and another would slide out of place as I soldered the next one in place. I gave this up as a bad job and started searching for a better solution.

In the junk box I found some ten-thousandths (0.010″) shim stock, and while looking at it, I came up with this idea for making connectors that work as well as the commercial ones. The process produces a symmetrical connector of uniform thickness permitting the calculation of the capacitance for by-pass purposes.

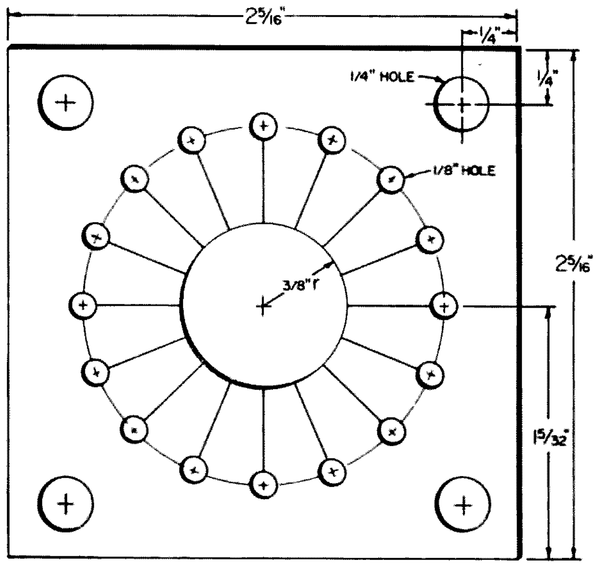


Fig. 1. Stock layout for 4X150A screen bypass.

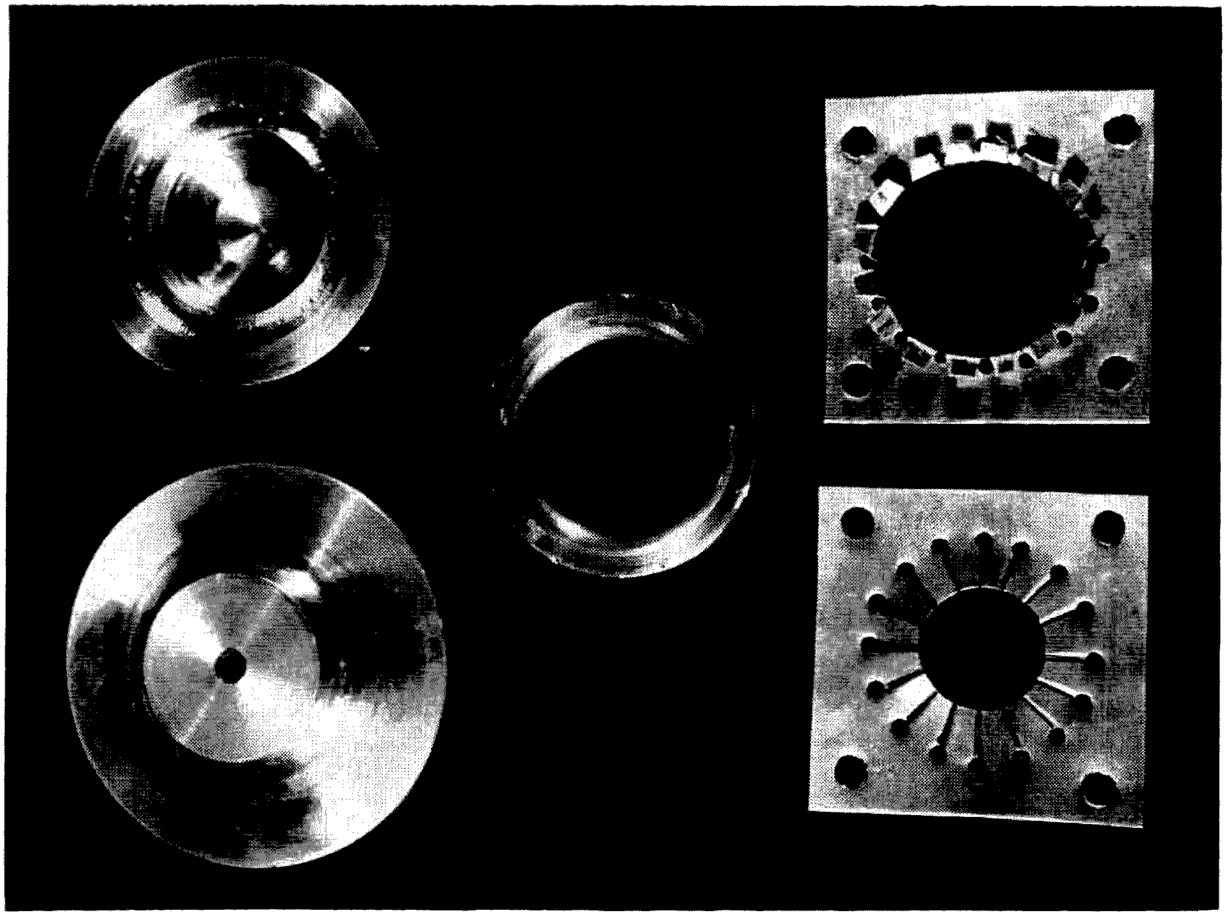
The first few that I made were rolled by hand, without the jig described, and were not as symmetrical as the later ones but worked quite well nevertheless. The connectors made in the jig were perfect fits and more uniform. The steps for making the connectors from shim stock can be easily duplicated in your own shack. The jig will require the use of a metal lathe, but the resulting connector is worth it. The dimensions for the jig and connector described here are for a screen by-pass connector for a 4X150A tube. For other coaxial tubes the dimensions will have to be altered accordingly.

The shim stock is prepared as follows:

1. Lay out the stock per the dimensions in **Fig. 1.**
2. Drill out all holes and punch out the center with a chassis punch.
3. Cut slits with a pair of scissors from the knock-out to the stop holes to form the fingers. (Roll the fingers by hand using round nose pliers or make yourself the jig.)
4. Place the stock on the base of the jig.
5. Force the washer down into place over the stock and then remove the washer leaving the stock on the base.
6. Force the top die down over the top of the base.
7. Remove the finished connector and install in the cavity or on the socket.

The jig is made of steel stock and is turned on a lathe according to the dimensions in Fig. 2. When turning the washer be sure to allow for the thickness of the stock or it will be difficult to remove in step 5. The top die must fit very closely or it will not catch the fingers and roll them properly. Shim stock of .005″ and .015″ were also tried and it was found

Bill is a professor of science at the State University of New York at Albany. He's taught a number of electronics and ham courses, including one on WTEN-TV.



On the left are the jig base and top, in the center is the jig ring, and on the right are a piece of stock ready to be formed and a finished connector.

that the .010 stock was the most satisfactory.

If the connectors are going to be used as grid connectors on planer triodes, do not use the top die, but use the connector as finished following the pressing of the washer on the jig base in step 5. When using two or more tubes in parallel or with common push-pull connection, you can make the connector of a single plate, laying out both tubes and punching on the jig twice. The photograph shows a finished connector, the stock lay-out, and the jig. The only inherent problem is that a jig must be manufactured for each diameter connector that you desire to make, but once the jig is made, it may be used forever and supply connectors for other members of your club. Make some of those vitally needed connectors and use those surplus high frequency tubes that have been gathering dust in the junk box. P.S. I don't own a lathe either. John Kowalchyk, a machinist friend, helped produce the first jigs that were made from the drawings. Later he was able to show me how to set up and use the lathe. This permitted me to make others myself. Joe Kelly, a fellow teacher, made the photograph.

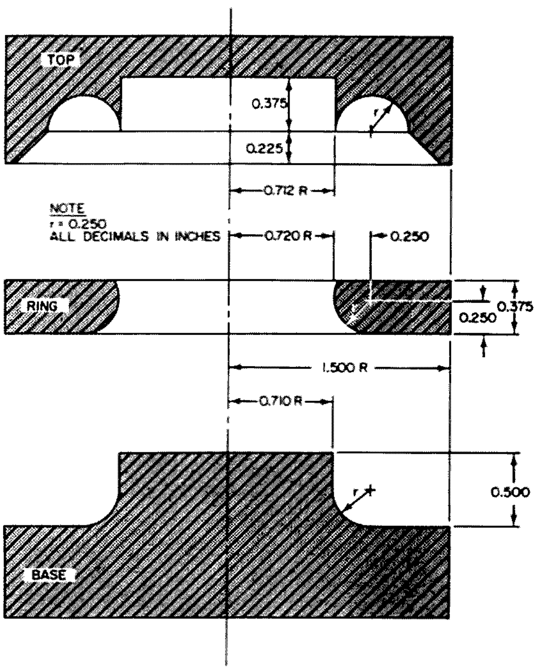


Fig. 2. Cross section of the jig.

. . . K2ZEL

1. Griffin, Frank WB6AOW, "Do-It-Yourself 4X150 Sockets," **VHF Horizons**, April 1963.

Fred J. Dietrich WØIFY/8
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Columbus, Ohio 43202

A DX Vertical

Here's a simple, effective antenna you can put up in almost no space.

The situation was about as impossible as one could imagine. The rig was a home-brew 100 watt cw transmitter with no drive above 20 meters, the receiver a none too stable 20 year old model, the back yard was full of power and telephone lines, the roof was fragile, slick slate, the rig was on the second floor, the line noise was often greater than S9, and I wanted to work DX! To make matters worse, the budget wouldn't allow more than about five dollars for an antenna, and being a student didn't leave much time for scrounging.

An important consideration was that of size, together with selection of the band or bands to be worked. Listening on a 67 foot wire that ran to a 25 foot high tree in the back yard revealed that the only two reasonable candidates for DX were 20 and 40 meters because of the sunspot situation. This wire had been used in an end-fed manner with a little DX success on 40 meters, but the competition from 40 meter beams and foreign broadcast stations made things pretty tough. The situation on 20 meters was about the same; it worked well for domestic contacts, but fell pretty flat when I tried to work DX.

In order to get the best DX coverage, it is necessary to put as much of the transmitter power as possible into the lowest radiation angle possible. This is so because most of the reduction in signal strength that takes place on an ionospherically reflected wave takes place where the wave passes through the lower layers of the ionosphere. The lower the radiation angle of the antenna, the fewer hops it takes to go between your QTH and those juicy DX locations. Also important is the fact that waves which take off at high radiation angles frequently pass through the ionosphere and are lost. This, of course, is just wasted power.

A study of the vertical radiation patterns for various horizontal antennas which appear in the first part of the ARRL Antenna Book reveals that it is necessary to get a horizontal dipole a half-wavelength or more high in order that the radiation angle be reasonably low. It is also important to notice that even if the antenna is fairly high, there is usually a good deal of radiation in power-wasting high-angle lobes. A fairly good compromise is a height of five-eighths wavelength. This gives a radiation maximum at about 25 degrees above the horizon, with something like 25 per cent of the power going into high-angle radiation. For 20 meters, this height comes out to something like 40 feet, and since there was nothing this high to attach to, a horizontal dipole seemed not too promising.

The vertical radiation patterns shown for a vertical dipole, on the other hand, are much more promising. In particular, the pattern for a vertical dipole with its center one quarter-wave above the ground (this means the lower end of the dipole is right next to the ground) shows a radiation pattern maximum at lower than ten degrees elevation angle when the antenna is located over average, not perfect, ground. There is also no loss of power at high angles because there are no extra lobes. This seemed to be the answer for working DX within the limitations of my QTH. A vertical dipole for 40 meters would be 70 feet high, a pretty tall order for the $5.00 budget and also for the limited space available for the guys which would be required for a mast of this height. For 20 meters, the height came out to be 33 feet 2 inches for the CW band, a height which could be supported by the house alone.

The antenna was mounted as shown in Fig. 1. The support points are the bottom of the mast and a point about two-thirds up the mast. This has proved adequate in winds up to 50

Fred is a research associate for the Ohio State University Antenna Laboratory. He has a BSEE, MSEE (Purdue), and is working on his PhD.

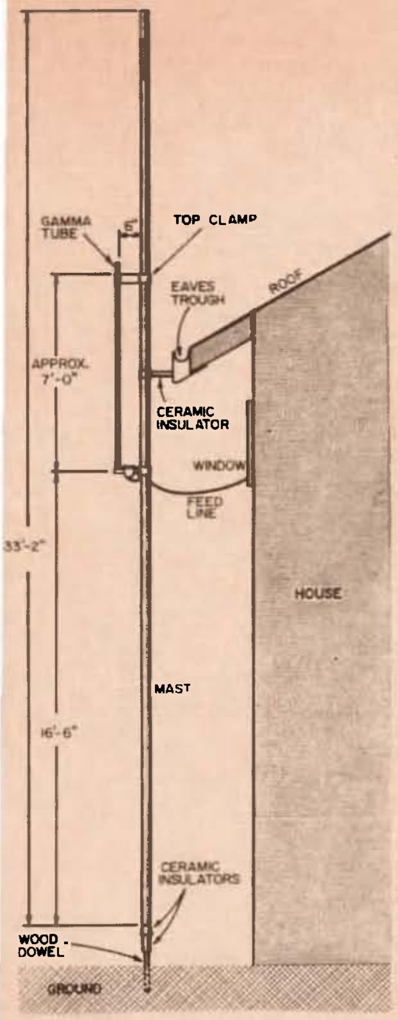

FIG. 1
GENERAL ARRANGEMENT

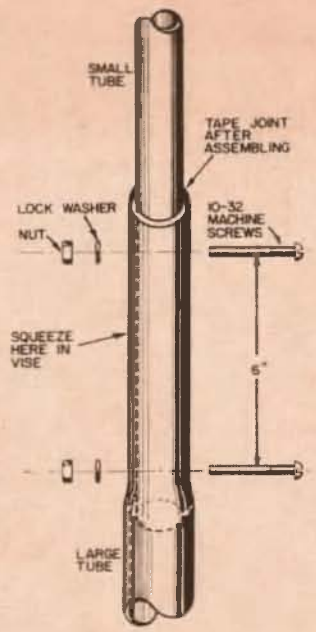

FIG. 2
MAST JOINT DETAIL

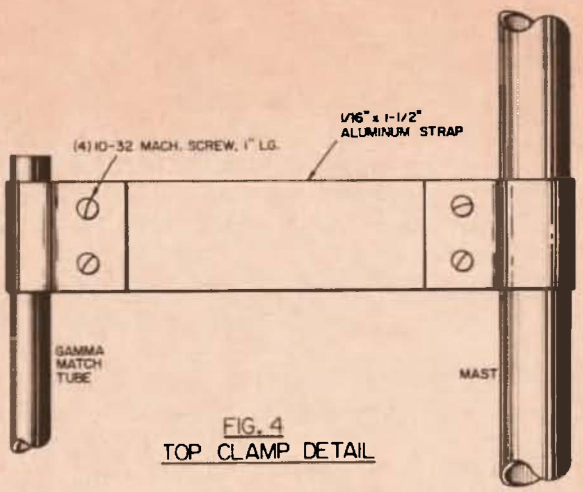

FIG. 4
TOP CLAMP DETAIL

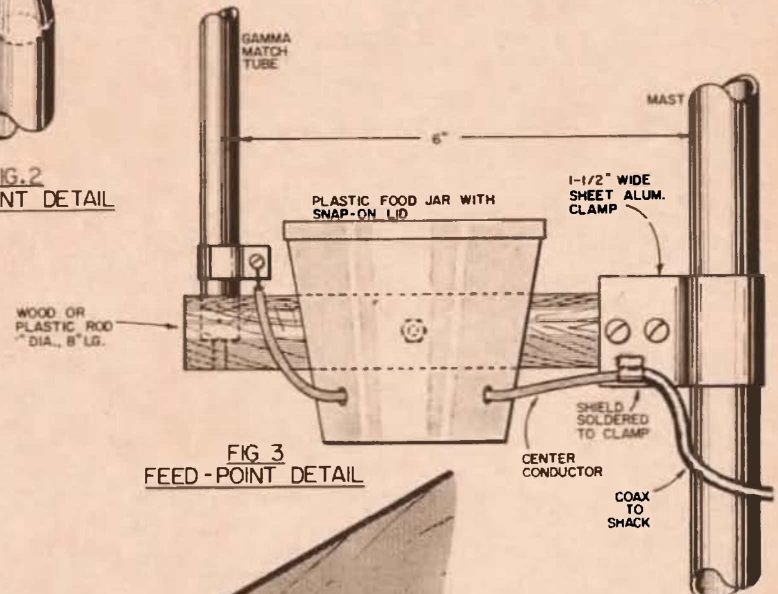

FIG 3
FEED-POINT DETAIL

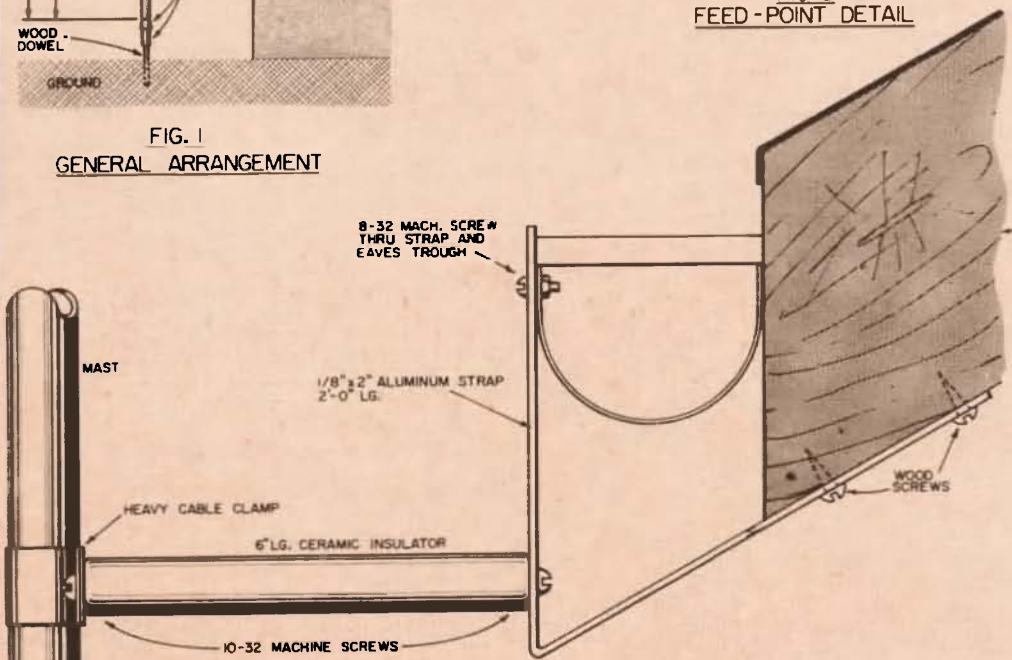

FIG. 5
UPPER SUPPORT

FIG. 6
BASE SUPPORT

NOTE - ALL HARDWARE CADMIUM PLATED OR STAINLESS STEEL

or 60 miles per hour, the highest usually encountered in this location. Since the dipole is a full half-wavelength long, it is conventional to feed it at the center. This turned out to be a rather convenient point in this case, as it fell near the height of a window in the second-floor shack. I chose to feed it with a gamma match to avoid splitting the mast in the center and to provide an unbalanced coax feedline. It should work equally well as a vertical doublet.

The antenna mast itself was assembled from various pieces of scrap aluminum tubing which were purchased during one morning's scrounging. If nice, long sections of telescoping tubing are available, by all means use them; I wasn't so lucky, but I still got the thing put together. In my particular one, the bottom 10 feet is a piece of one inch aluminum conduit, the center section is a two section thinwall aluminum TV mast about 13 feet long, the next section is a discarded TV antenna boom with the elements removed, and the remainder of the 33 foot 2 inch length is made up of two pieces of aluminum tubing scrap. This length was found from the equation $L = 468/f(MHz)$ where L is in feet.

Since the tubing didn't telescope together nicely, it was necessary to devise some means of fastening them together. This was accomplished by squeezing the larger of the two tubes for a particular joint in a vise until it was narrow enough to provide a tight fit for the smaller tube. The joint was then bolted with two bolts about six inches apart through both tubes. **Fig. 2** illustrates the method. All the joints were taped with plastic electrical tape after they were assembled to keep moisture out. Cadmium plated hardware was used everywhere to prevent corrosion and rust. Stainless steel hardware would be even better, but I have seen no signs of rust after two years with the hardware I used.

Fig. 3 shows the details of the gamma feed arrangement. The gamma tube is fed from the center conductor of the coax through a 33 pF variable capacitor which is enclosed in a plastic refrigerator jar to protect it from the weather. It is important to drill a small hole in the bottom of the jar to allow condensation to drain out. I learned this the hard way. I didn't provide a hole, and after about 6 months of operation there was about a half inch of water standing in the bottom of the jar. Changes in barometric pressure cause the jar to "breathe" humidity inside. The top of the jar is removed to adjust the capacitor during initial tuning. Once it is tuned, the lid is snapped back in place. The jar attached to the wooden dowel with a long 6-32 screw which passes through the dowel, through the jar, and screws into one of the mounting holes of the variable capacitor. This joint was sealed with mastic cement between the jar and the dowel to prevent rain from entering the jar at this point.

The gamma tube is supported on the bottom by being set into a hole drilled partway through the dowel. This should be of such a size to provide a snug fit for the tube. A small hole, concentric with the large one, was drilled entirely through the dowel to allow rain to pass freely through the gamma tube and out the bottom. The electrical connection is made at the bottom of the tube by means of a clamp made from scrap sheet aluminum and fastened with a 6-32 machine screw which also holds the solder lug for the wire from the capacitor. This joint was taped after completion of the antenna. The top clamp is shown in **Fig. 4**, and consists merely of a piece of sheet aluminum formed into clamps at both ends.

Fig. 5 and **6** show the details of mounting. The long ceramic insulators shown happened to be on hand; probably something smaller in size would be adequate. The mast turned out to be only about three feet from the wall of the house. A larger spacing would be desirable from the standpoint of efficiency, but the property line prevented it.

Adjustment of the gamma match proceeded as follows. The transmitter frequency was set to the center of the desired frequency range (in my case it was 14050 kHz) and the output power was adjusted for the minimum required to give full-scale deflection on the SWR meter. (An SWR meter or impedance bridge[1] is essential for the proper tuning of any antenna system.) If possible, choose a time when the band is dead so as to cause a minimum of interference. Before keying the transmitter, set the top gamma tube clamp to some position, say 6 feet above the center of the antenna, and tighten it. (now take your hands off the thing!) Key the transmitter and adjust the variable capacitor until the standing wave ratio is minimum. If the reading at minimum is too high, move the clamp up or down a few inches and repeat the procedure. If this improves the SWR, move the clamp again in the same direction. If the SWR goes up, move the clamp in the opposite direction. If the SWR cannot be brought to a satisfactory level, it might be necessary to move the center clamp on the antenna up or down a few inches. The part of the antenna which is close to the wall of the house will be somewhat detuned by the house, and the electrical center of the antenna might not be located at the exact mechanical center. It should be possible to get the SWR down to

[1] Kyle, Jim, "R.F. Measurements," 73, Dec. 1965, p. 20.

I to 1 at the center frequency; I quit when I hit 1.25 to 1. It stays below 1.75 to 1 anywhere in the CW band, which is entirely satisfactory for all but the most touchy transmitter pi-network.

The tuning was accomplished by having one man on an extension ladder and the other at the rig. Since the total feed line length for my installation was only seven feet, and the window it passed through was left open during the tuning procedure, there was no problem of communication between the man at the rig and the man on the ladder.

A convenient feature of this antenna is the ease with which it may be lowered for inspection and repair. It is necessary only to remove one screw from the upper insulator, disconnect the feed line from the transmitter, tie a strong cord to it above the center, and lower away. I am able to do this from inside the shack by opening the upper half of the window. To raise it, it is necessary to have someone position the bottom of the mast over the bottom cone insulator and hold it there while I raise it back to a vertical position. The XYL performs this task admirably.

A note about radials. One of the reasons for selecting this type antenna is that it is center fed and does not require radials for efficient operation. The more popular vertical is a quarter-wave type which must be fed against a radial system or some other form of ground. The reason that many of these fail to live up to their expectations is because of an inadequate counterpoise. A single ground rod at the base of a quarter-wave antenna is usually not adequate. I know; I've tried it with disastrous results! The transmitter power is dissipated in large ground resistance which results from a poor ground. A good system of buried radials is excellent for a quarter-wave vertical, and a system of radials above ground for the popular ground plane antenna works well. I did not have room near or in the ground, and the fragile roof and a landlord who discouraged me from walking on it prevented the erection of anything on the roof.

I did try stringing some radials in the basement and feeding the whole mast against these for 40 meter operation using a variation of the bazooka balun feed, but that's another story.

On the air results have been very encouraging in the relatively little operating time I've had available. A check in the log shows mostly 569 and 579 reports out of Europe and 589's out of Central and South America. Since I am restricted to Saturday morning operation, I don't usually hear the Asian and Pacific stations.

. . . WØIFY/8

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An AC Voltbox

Does the line voltage tend to wander about a bit at your QTH? Or are you checking out new gear and needing a way to simulate high or low line-voltage conditions?

One way out of these (and all similar) problems is to buy an adjustable autotransformer. General Radio calls them "Variacs" and other people have other names for the gadgets, but they're not too unfamiliar.

However, they *are* expensive. In sizes rated for any power capability at all, they begin to make sizable dents in the region of the pocketbook. Even in surplus!

Another way out of the problem is to build yourself a voltbox. It won't have *quite* the flexibility of the variable transformer, but on the other hand it won't cost nearly as much either. In fact, you can build a stripped version out of most anybody's junkbox.

The trick of hooking up a low-voltage transformer so that its secondary is in series with the line voltage is as old as the hills. It must even have had whiskers when Signore Marconi tapped out his famous three dits. And that's the basis of the voltbox.

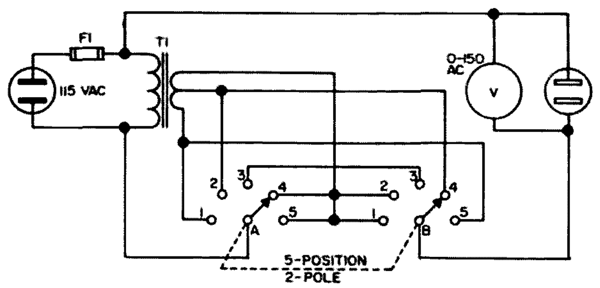


Fig. 1. Schematic diagram for voltbox. T1 can be any filament transformer. Power capacity of voltbox will be product of transformer secondary current rating and (line voltage minus secondary voltage). F1 should be rated same as secondary of T1. As shown, output voltage will be (line minus secondary) at switch position 1, (line minus half secondary) at position 2, straight line at 3, (line plus half secondary) at 4, and (line plus full secondary) at 5. If secondary windings happen to be reversed in polarity from that shown, only effect will be to make position 1 the **high** end of the range and position 5 the low.

But it's a bit more than that. The simple series-secondary hookup is fine for either boosting or lowering line voltage by a fixed amount. It even lends itself to use of a dpdt switch to take your pick of boost *or* cut. But it's not much for rapid control.

By using a center-tapped filament transformer, however, and a 2-pole rotary switch with 5 positions, it's not too hard to get a sort of "active power rheostat" effect. The schematic shows the hookup. In position 1 of the switch, the full secondary of the transformer is in series with the line and out of phase, so that if we're using a 10-volt center-tapped transformer and have a constant line voltage of 115 the Voltbox output will be 105 volts at this point.

Position 2 cuts out half the secondary, so we have only 5 volts to work with, but retains the same phasing. Now we have 110 volts out.

Position 3 eliminates the transformer altogether for straight through 115-volt operation. Position 4 is the same as position 2 but the phase is now such that our 5 volts *adds;* we get 120 volts out. Finally, position 5 adds the full 10 volts for 125-volt output.

So by the twist of a switch, we go from 105 to 125 volts in 5-volt steps. Had we used a 25-volt center-tapped transformer, the range would have been from 90 to 140 volts in 12½-volt steps.

The fuse shown in the schematic is for the protection of the transformer; the voltmeter across the output socket is simply a convenience so that you can monitor output voltage constantly.

Some TV power transformers have double 6.3-volt secondary windings, with at least one of them centertapped, as well as a 5-volt rectifier winding. These can be used to build a really wide-range Voltbox; the output steps could be arranged as 97.4, 102.4, 108.7, 111.85, 115 (line), 118.15, 121.3, 127.6, and 132.6. This would require a 9-position 2-pole switch. Wiring would follow that of the schematic except that all secondaries would be hooked up in series with the center-tapped winding at the bottom of the string and the 5-volt winding at the top. Measuring secondary voltages from the bottom of the string, you would have 3.15, 6.3, 12.6, and 17.6 volts. The bottom connection would go to switch position 1 on wafer A and the 17.6-volt end would go to positions 1, 2, 3, and 4 on wafer B and 6, 7, 8, and 9 on wafer A. Intermediate connections would go to 2, 3, and 4 on A (in order) while positions 1 through 4 on A would connect to 6 through 9 on B in the same way as 1 and 2 connect to 4 and 5 in

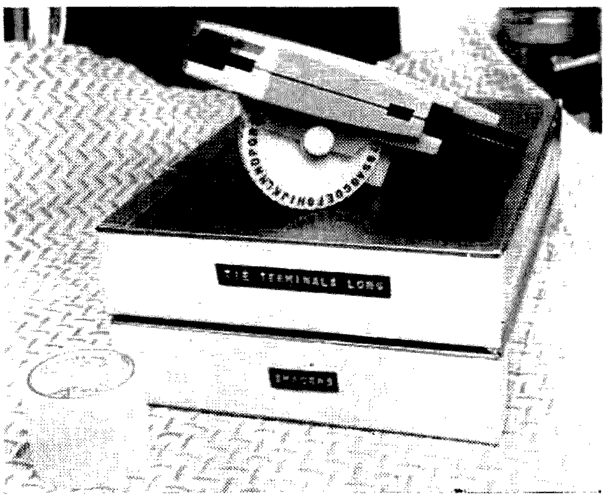
the schematic; positions 5 on both wafers connect together for a straight-through connection.

In such a hookup, power rating would be limited by the lowest current rating of the individual windings. Thus maximum output current might not be greater than 600 ma, or about 70 watts worth of power at 117 volts.

In the hookup shown in the schematic, power rating is equal to the current rating of the secondary multiplied by the *lowest* output voltage. It will increase at higher output voltages but this provides you a safety margin. Using a 10-volt 5-amp transformer you'll have a power rating of more than 500 watts—plenty to run any receiver or VFO, and adequate for a performance test on much other equipment.

The same idea can be applied as an input-power control for a low-power transmitter, since output of a 600-volt power supply can be varied over a ±50-volt range by the 105/125 volt range of the Voltbox. You'll probably discover dozens more uses for this handy gadget as soon as you have it finished and use it for a while!

. . . K5JKX



Parts Storage

Cigar boxes are much more satisfactory for storing small parts than the plastic drawer type cabinets. If you have ever tried to close a drawer full of resistors you will know what I mean.

First it is important to stock up on all types of cigar boxes. To do this you will probably have to get on the cigar store waiting list. When you have a sufficient assortment of boxes take the ones of the same size for each type of component you want to store. Over a period of time and with enough shuffling from one box to the other, and end result will be a neat storage for your small parts.

. . . Ed Marriner W6BLZ

Gus Browning W4BPD
Orangeburg, S.C.

Gus: Part 16

Last month I was on Aldabra Island having a ball. After repairing the Teflon needle valve with a hot soldering iron and getting my antennas broadside to the USA and Europe, I was all set for the pile-ups.

I found that there were interesting things to observe on the islands. I saw the Booby birds trying to battle their way thru with their craw full of fish every evening (read last month's issue). Or take those coconut crabs that invaded the back porch where I was operating every night. These are mean rascals about twice the size of both of your fists when placed together. They just love to sneak up on you at night (they don't come out in the daytime), and when you are not watching all of a sudden they will take a snip at your leg; I mean right up under your pants cuffs. They are always fighting each other; usually every morning there were a number of dead ones laying around that got killed during the night. I think they hate each other and think nothing at all about "battling to their death" at the first sight of another one. Sometimes when I awoke by the operating position in the morning there even were a few dead ones on top of the table. I suppose they climbed up on the table via the overhanging table cloth. I guess they would make FB house pets if you did not want any of your neighbors visiting you. One night I caught about 25 of them and placed them in a large box so that I could take a picture of them the next day, but the next morning every one of them was dead. I suppose they had a real battle royal in that box during the night. All of them were snipped up; pieces of coconut crabs were all over the box; not a whole one was to be found.

Another interesting type of nightly visitor was some extra large bats. I will tell you of my encounter with one of them the very first night I was there. My operating table was on the back unscreened porch. I had been noticing something flitting between me and the light bulb a number of times, and thought possibly it was a large candle fly or something like that. I had a nice pile-up going, operating SSB on 20 meters. Someone had just called me and I was about to jot down the call sign of the station calling, but all of a sudden, something lit on top of my partly bald head. This "thing" was straddling my headphone band (the mike was also mounted from this headphone band) and its claws were dug into my very thin hair and scalp. I yelled into the mike, "Just a minute, Buddy, I got some trouble here." Then I sort of sneaked my hand up to my head to feel this thing that was on top of it, nice and soft. I quickly withdrew my hand from this little fur covered thing setting on top of my hair. I sort of froze up for a minute, and then decided this thing had to be removed from my head. I had to either do something or else sit there all night. I decided to do something and to do it instantly. I grabbed this thing from my head, and threw it on the floor, all in one single motion. Down on the floor went the headphone, mike and this thing, which turned out to be a large bat having a wing spread of about 20 inches. The poor headphone and mike really slammed to the floor; I thought for sure they were ruined. The bat was out cold. I picked up the phones/mike combination and listened in, whistled in the mike once and discovered it was all OK. I was back in business again. Then I said into the mike, "Who was that calling me?"—the wrong thing to say in a pile-up. Back came about 25 stations; whoever was calling me on that frequency was clobbered. I then put a little check mark beside the time and report I had already entered in the log. In the excitement I completely forgot the call sign of whatever was calling me. Sure enough when I got back home, I found a QSL card from this fellow all filled in with the proper time, date, report, etc. He mentioned I had returned to his call and that right after I had given him his report said, "Wait a minute; I've got troubles." Then when these troubles were over with he got smothered with QRM. I sent him a QSL card. I even wrote him a letter telling him what the trouble was that I had. I never did have one of those bats land on my head after that. I sort of learned to live with them from then on.

At the time I was on Aldabra, the total

population was about 20 people. There are three industries on the island—fishing, copra, and catching large sea turtles. Which is the best money producer I have no idea. Possibly it's the fishing. The fishermen are more afraid of the large groper fish than they are of sharks. It seems that these gropers sort of sneak up on the fishermen (who are in the water spearing fish), and take a chunk of meat out of him now and again. One fellow I met down there had the calf of his lower right leg completely gone from a groper bite. They told me they can usually scare a shark away by making lots of commotion in the water.

The catching of the large sea turtles was interesting work to observe. Usually three fellows go out in one of the large pirogues (boats). When a turtle is seen they row the boat near the turtle, and they throw a spear into the back of the turtle; the spear only goes into the turtle's back a few inches. The turtle is hauled into the boat, turned over on its back and then a few more are caught. When they have a good haul they come ashore and the turtles are placed in the turtle pond. The spearing of the turtle does him no harm since the spot where the spear went thru its soft back soon heals over and the turtle is as good as he ever was.

Life on Aldabra to me seemed very good; everyone had all the food they needed for I believe each one there was allowed one pound of rice per day. If they did not use their ration the owner of the island bought the rice back from them at a fair price. I saw no one beating their brains out working themselves to death. They all seemed to be sort of taking it easy. I think they are all very satisfied with their job. Of course, occasionally there is a little trouble between a few fellows, which the island manager soon clears up. There is even a small jail on the island that on occasion is occupied, but not very often. I suppose the island manager is the judge in these disputes. Life to me on Aldabra was very enjoyable; the bands were open nearly around the clock. With the sun spot count increasing each day now, I certainly would like to return to Aldabra. With even 10 meters starting to open again I bet I would have a ball. Remember when I was down there the sun spot count was near the 11 year minimum. The possibility of my returning there at this time seems to be very remote, if not impossible; but if the chance ever turns up I would like to be on again from down there. Oh, yes, if you want one of the most delicious meals in the world, try one of the Aldabra turtle steaks. They are one of the most tender steaks I have eaten.

If you are interested in picking up sea shells by all means go to the Aldabras; they are there by the thousands just waiting for someone to pick them up. I sent Peggy two large boxes of them. I had already sent her other sea shells from other spots and she told me, "No more sea shells, please." One extra large clam fossil I found there was large enough for me to lay down in and be closed shut. We shipped this one back to Mahe to be put in their museum. The clam from that shell would have fed 30 or 40 people, I guess. Its age was estimated to be more than a thousand years old. With all the birds, fish, copra, sea shells, bats, and miles and miles of nice sandy sea coast, life there is not bad at all. All the workers there are men, so there is never any trouble with arguments over some woman.

I stayed on Aldabra Island for 17 days. I found that 17 days is by far too long to stay at one QTH as far as DXpeditioning is concerned. Give me 7 good days and everyone will be worked who really tries; after that you have to start digging for QSOs. But I was sort of stuck for those 17 days, since Jake the boat owner had the little Lua-Lua up high on the beach, painting and cleaning it up. He put it up on high dry sand when the moon was full and had to wait until there was the next extra high tide so he could float it away again. This extra long stay was not too bad, since there were many things of interest to do and to look at. Time flew by anyway.

Finally Harvey gave me a call on 20 and said for me to be ready to depart the next morning at 8:30 AM. Down came the antenna, off went the power plant, things were all wrapped up and made ready to load up the boat. I contacted the manager of the island and told him I would need the use of a pirogue the next morning with a few fellows to help me load up and row out to the Lua-Lua when it arrived. To bed I went for the first good long night's rest I had since I had arrived at Aldabra. I visited all the workers and thanked them all for their help, thanked the island manager and took one final look at the camp site. I was ready to QSY from Aldabra at 8:00 AM.

The Lua-Lua arrived at about 8:15, so out we went in the loaded pirogue. The old SE monsoon by this time had really got going and we had a heck of a time loading the equipment from the pirogue to the Lua-Lua. A number of times things nearly went overboard, until we got the swing of the way the waves were behaving. We would watch for a big swell to start our way, and yell to the fellows in the Lua-Lua to get all set; then we grabbed an armful of items and waited until the swell pushed our pirogue up high, parallel with the deck of the Lua-Lua, and in a fast swing handed items to the outstretched arms of the fellows in the Lua-Lua. This required some split second timing and fast movement on the part of the fellows on both boats. The last item to leave the pirogue was me. The pirogue departed for the beach, and we set sail for Mahe.

The seas were in a very foul mood all the way back. I finally managed to get my equipment mounted on the eating table, the old putt-putt fastened down, and I was again /MM. Quite a number of waves swept completely over the ship, and the fellows at the wheel hung on for dear life so they would not be swept overboard. What a time we had trying to shoot the sun, moon, Venus, etc., with the horizon very vague; locating the horizon was a must before any bearings could be taken. All this time I am at the radio listening to WWV or some other station with standard time signals, calling off the seconds. Both Harvey and Jake had their sextants in their hands. Eventually we would get a shot and Harvey and Jake would then go to their little desks and start trying to figure where we were! Every now and again they would actually agree on the same exact spot. One time one of them called out the answers to his shot and according to my map we would have been about 300 miles west of Cairo, Egypt, out in the Sahara Desert! He later re-figured and found that he had subtracted one of his figures instead of adding. But as a rule their figures more or less agreed. Dead reckoning helped quite a bit also. In plain English, dead reckoning means you are located at such and such a place using common sense.

The second day out from Aldabra, on the way back to Mahe, I was on the air having a FB time QSOing the boys with those breakers breaking over the boat, and bango—the sky light above my operating table was struck by an enormous wave, it was lifted up and about a bathtubfull of sea water came on top of me, the equipment, cameras and all. This brought a sudden silence to the equipment. It was silent all the rest of the way back to Mahe. I tried drying it off the best I could with what damp clothes we had on deck, but it was a long way from being dry. It took us about 10 days to battle our way back to Mahe; all this time the equipment just lay there with the salt water doing its worst to it, parts of the chassis starting to turn green when we arrived on Mahe. It did not look good to me at all; I thought for sure that I would have to get word to Ack to send me another KWM-2, but before I sent out this distress message I de-

cided I would try overcoming this salt water trouble.

Off went the cabinet, and the scrubbing job began. After two days of hard work, it looked very nice and clean. I plugged it in, expecting the smoke to rise from somewhere. There was no smoke from it, but there were no signs of any signals from it either. Nor was there any excitation on transit. The only thing that moved was the S meter, and it moved backwards. It looked like I was in for lots more cleaning before there were going to be any signals from VQ9A. This time I really dug in. First it got the water hose treatment! Try squirting water down in those pretty little *if* transformers; you will be surprised the places it squirts out! After a few days of this cleaning, wiping, polishing, and sponging, things looked very good. This time I placed the equipment out in the hot Mahe sunshine for two days, turning the chassis over every hour; finally on the third day I placed it in the oven at the hotel, turned the heat up to 160 degrees and let it cook for 6 hours. This time I knew it was dry before I plugged it in. Still the S-meter read backwards, and a very faint hum could be heard from the phones. On PA plate current position the meter read about 15 mils. Still, no excitation. This time I was ready to send Ack that distress message for sure. After some thought I decided I would try just once more before sending this message to Ack. This time out came most of the parts, the *if* transformers inside were all green, covered with green scum and mildew. Each one was very carefully cleaned with carbon-tet; the trimmers were taken apart and I noticed the silver plating on them was starting to peel off; the power transformer was even taken apart and found to be covered with this green scum. Sometime one of you fellows might try a real cleaning job on the little band switches in modern-day equipment. This time I spent 3 full days cleaning; then back into the oven again for more baking, and then with not much hopes it was plugged in. Again the S-meter read backwards—but the receiver was operating again. Next I tried the transmitter. By golly, it worked! ! !

I was back in business again at VQ9A. I could never get the VFO to calibrate right, and when I returned the set to Collins about two years later, the S-meter was still reading backwards. They sent me a new VFO to install so the calibration difficulty was eliminated. I never did have any more trouble with the rig after that, except the usual amount of tube trouble.

. . . Gus

WTW Country List

AC 1, 2, 5, 6, 7, 8, 9, Ø—Bhutan
AC3—Sikkim
AC4—Tibett
AP—East Pakistan
AP—West Pakistan
BV, C3—Formosa (Taiwan)
BY, C—China
CE—Chile
*CE9—See KC4
CEØA—Easter Island
CEØX—San Felix
CEØZ—Juan Fernandez
CM, CO—Cuba
CN—Morroco
CP—Bolivia
CB3, 5—Portuguese Guinea
CB4—Cape Verde Islands
CR5—Principe, Sao Thome
CR6—Angola
CR7—Mozambique
CR8—Portuguese Timor
CR9—Macao
CT1—Portugal
CT2—Azores
CT3—Maderia
CX—Uruguay
DJ, DL—German Fed. Rep. West)-RFU
DL, DJ—West Berlin
DM—German Democratic Rep. (East)-RFU
DU—Phillipines
EA—Spain
EA6—Baleric Is.
EA8—Canary Is.
EA9—Ifni
EA9—Rio de Oro
EA9—Spanish Morroco
EAØ—Rio Mundi & Fernando Poo Is.
EAØ—Spanish Guinea
EI—Rep.of Ireland
EL—Liberia
EP—Iran
EA3, 9E3, 9F3—Ethiopia
F—France
FB8—Amsterdam & St. Paul Is.
FB8—Crozet Is.
FB8—Kerguelen Is.
FB8—French Antartica-REF
FC—Corsica
FG7—Guadeloupe
FH8—Comoroes Is.
FK8—New Caledonia
FL—French Somaliland
FM7—Martinique
FO8—Clipperton Is.
FO8—Loyalty & Chesterfield Is.-REF
FO8—Touboual (Austrail Is.)-REF
FO8—Tuamotou (Gambier Is.)-REF
FO8—Marquessa Is.-REF
FO8—Austrail Is. (except Toubouai)-REF
FO8—Society Is. (Tahiti)-REF
FP8—St. Pierre & Miquelon
FR7—Reunion Is.
FR7/G—Glorieuses Is.
FR7/J—Juan de Nova & Europe Is.
FR7/T—Tromilen Is.
FS7—Saint Martin Is.
FU8, YJ1—New Herbides Is.
FW8—Wallis & Futuna Is.
FY7—French Guiana & Ininl
G, GB—England
GC—Guernsey & Dependencies
GC—Jersey Is.
GD—Isle of Man
GI—Northern Ireland
GM—Scotland
GW—Wales
HA—Hungary
HB—Switzerland
HE, HBØ—Liechtenstein
HC—Educador
HC8—Galapagos
HC8E, KX6—Ebon Atoll
HH—Haiti
HI—Dominican Rep.
HK—Colombia
HKØ—Bajo Nuevo
HKØ—Malpelo Is.
HKØ—San Andres & Providencia Is.
HL, HM—Korea (South)
HM—Korean Peoples Rep. (North)
HP—Panama
HR—Honduras
HS—Thailand
HV—Vatican
*HZ—See 7Z
I1—Italy
IS1—Sardenia
IT1—Sicily-DARC
I1—Trieste-DARC
JA, KA—Japan
JT—Mongolia
JY—Jordan
K, W, WA, WB, etc.—USA
*KA—See JA
KB6—Baker, Howland & American Phoenix
*KC4U—Antarctica (see CE9)
KC4—Navassa Is.
KC6—Eastern Carolines
KC6—Western Carolines
KC6—Palau-NZART
*KG1—See OX
KG4—Guantanamo Bay
KG6—Guam
KG6—Marcus Is.
KG6—Mariana Is.
KG6I—Bonin & Volcano Is.
KH6—Hawaii Is.
KH6—Kure Is.
KJ6—Johnson Is.
KL7—Alaska
KM6—Midway Is.
KP4—Puerto Rica
KR6—Ryuku Is.
KS4—Swan Is.
KS4B—Serrana Bank & Rancador Cay
KS6—American Samoa
KV4—Virgin Is.
KW6—Wake Is.
KX6—Marshall Is.
KZ5—Canal Zone
LA—Norway
LA/P—Jan Mayen
LA/P—Bear Is.-DARC
LA/P—Svalbard
LH4—Bouvet Is.
LU—Argentina
LU Z—(see KC4)
LX—Luxembourg
LZ—Bulgaria
M1, 9A1—San Marino
MP4B—Bahrein Is.
MP4M, VS9—Sultanate of Muscat & Oman
MP4Q—Qatar
MP4T—Trucial Oman
OA—Peru
OD5—Lebanon
OE—Austria
OH—Finland
OHØ—Aland
OK—Czechoslovakia
ON—Belgium
OR4—(see KC4)
OX, XP—Greenland
OY—Faroes
OZ—Denmark
PAØ, PI1—Netherlands
PJ—Dutch West Indies
PJ2M—Sint Maarten
PX—Andorra
PY—Brazil
PYØ—Fernando de Noronha
PYØ—St. Peter-&-Paul Rocks
PYØ—Trindade & Martim Vaz Is.
PZ—Surinam
SL, SM—Sweden
SP—Poland
ST—Sudan
SU—Egypt
SV—Greece
SV—Dodecanese Is.
SV—Crete
TA—Turkey
TA—European Turkey-DARC
TF—Iceland
TG—Guatemala
TI—Costa Rica
TI9—Cocos Is.
TI9C—Comoran Reef
TJ—Cameroun
TL—Central African Rep.
TN—Congo Rep.
TR—Gabon Rep.
TT—Chad Rep.
TU—Ivory Coast
TY—Dahomey Rep.
TZ—Mali Rep.
UA, UV, UW 1 thru 6—European Russia-RFU
UA—Russian Antartica-RFU
UA1—Franz Josefland
UA2—Kaliningradsk
UA, UW, 9, Ø—Asiatic Russia
UAØ—Dickson Is.-RFU
UAØ—Magadan Is.-RFU
UAØ—Taimar-RFU
UAØ—Tuva ASSR-RFU
UAØ—Chukotsk-RFU
UAØ—Yakut ASSR-RFU
UAØ—Sakhlin Obl.-RFU
UB5, UT5—Ukrain
UC2—White Russia
UD6—Azerbaijan
UF6—Georgia
UG6—Armenia
UH8—Turkoman
UI8—Uzbek
UJ8—Tabzhik
UL7—Kazakh
UM8—Kirghiz
UN1—Karelo-Finnish Rep.-DARC
UO5—Moldavia
UP2—Lithuania
UQ2—Latvia
UR2—Estonia
VE, VO—Canada
*VO—See VE
VK—Australia
VK—Lord Howe Is.
VK4—Willis Is.
VK9—Christmas Is.
VK9—Cocos Is.
VK9—Nauru Is.
VK9—Norfoflk Is.
VK9—Papua Territory
VK9—Territory of New Guinea
VKØ—Heard Is.
VKØ—Macquarie Is.
*VKØ—See KC4
VP1—British Honduras
VP2—Antigua, Barbuda
VP2—Anguilla
VP2—British Virgin Is.
VP2—Dominica Is.
VP2—Grenada Is.
VP2—Monstserrat
VP2—St. Kitts and Nevis
VP2—St. Lucia
VP2—St. Vincent & Dependencies
VP3—British Guiana
*VP4—See 9Y4
VP5—Turks & Caicos
VP6—Barbados
VP7—Bahamas
*VP8—See KC4
VP8—Falkland Is.
VP8—So. Georgia
VP8—So. Orkneys
VP8—So. Sandwich Is.
VP8—So. Shetlands
VP—Bermuda
VQ1—Zanzibar
VQ8—Agalega & St. Brandon
VQ8—Chagos
VQ8—Mauritius
VQ8—Rodriguez Is.
VQ9—Aldabra Is.
VQ9—Seychelles
VQ9—Desroches
VQ9—Farquahar Is.
VR1—British Phoenix Is.
VR1—Gilbert, Elis, & Ocean Is.
VR2—Fiji
VR3—Fanning & Christmas Is.
VR4—Solomon Is.
VR5—Tonga Is.
VR6—Pitcairn Is.
VS5—Brunei
VS6—Hong Kong
VS9—Aden & Socotra
VS9H—Kuria Mauria Is.
VS9K—Kamaran Is.
VS9M—Maldive Is.
VU2—Andaman & Nicobar Is.
VU2—India
VU2—Laccadive Is.
*W—See K
XE, XF—Mexico
XE, XF—Revilla Gigado
XT—Voltaic Rep.
XU—Cambodia
XV—South Viet Nam-RFU
XW8—Laos
XZ2—Burma
YA—Afghanistan
YI—Iraq
TK—Syria
YN—Nicaragua
YO—Rumania
YS—Salvador
YU—Yugoslavia
YV—Venezuela
YVØ—Aves Is.
ZA—Albania
ZB2—Gibraltar
ZD3—Gambia
ZD5—Swaziland
ZD7—St. Helena
ZD8—Ascension
ZD9—Gough & Tristan de Cunha

ZE—Rhodesia
ZF1—Cayman Is.
ZK1—Cook Is.
ZK1—Manihiki Is.
ZK2—Niue Is.
ZL—Auckland & Campbell Is.
ZL—Chatham Is.
ZL—Kermidac Is.
ZL—New Zealand
*ZL5—See KC4
ZM6—Western Samoa
ZM7—Tokalaus Is.
ZP—Paraguay
ZS1, 2, 4, 5, 6—South Africa
ZS2—Marion & Prince Edward Is.
ZS3—South West Africa
ZS7—Swaziland
ZS8—Basutoland
ZS9—Bechuanaland
1M4—Maria Teresa
1S9—Spratley Is.
3A—Monaco
3V8—Tunisia
3W8—North Viet Nam-RFU
4S7—Ceylon
4U—I.T.U. Geneva, Switzerland
4W—Yeman
4X—Israel
4X1—Israel/Jordan Demilitarized Zone
5A—Libya
5B4 ZC4—Cyprus
5H3—Tanganyika
5N2—Nigeria
5R8—Malagasy
5T—Maurantania Rep.
5U7—Niger Rep.
5V—Togo Rep.
*5W1—See ZM6
5X5—Uganda
5Z4—Kenya
60—Somali Rep.
6W8—Senegal
6Y5—Jamaica
7G1—Rep. of Guinea
7Q7—Malawi Rep.
7X—Algeria
7Z(HZ)—Saudi Arabia
8F—Indonesia
8Z4—Saudi Arabia/Iraq Neutral Zone
8Z5, 9K3—Kuwait/Saudi Arabia Neutral Zone
*9A1—See M1
*9E, 9F—See ET
9G1—Ghana
9H1—Malta
9J2—Zambia
9K2—Kuwait
*9K3—See 8Z5
9L1—Sierra Leone
9M2—West Malaysia
9M6, 8—East Malaysia
9M4—Singapore
9N1—Nepal
9Q5—Rep. of the Congo
9U5—Burundi
9X5—Rwanda
9Y4 (VP4)—Trinidad and Tobago

All countries are from ARRL list except those marked with one of the following:
DARC—Deutscher Amateur Radio Club (West Germany)
NZART—New Zealand Association of Radio Transmitters
REF—Réseau des Emetteurs Francais (France)
RFU—Radiosport Federation off the USSR
The asterisks indicate additional prefixes for a country.

Gus Browning W4BPD
c/o 73 Magazine
Peterborough, N.H.

The WTW and You, Mr. DX'er

The Fall DX Season is upon us again. This is the time of year when the DX will be coming thru with those strong signals. With the sun spots getting a little bit more plentiful every month, DX'ing will be FB for a good many years now. After that the spots will taper off and we all will be getting older and older. By the time the next peak comes around some of us won't be here to enjoy the FB DX'ing that can and will probably take place again. Or by that time the frequency allocation conference will have taken place, and maybe our bands will all be stolen from us by the commercials or other folks that are eyeing them right now. So I say if you are interested in working DX, now is the time to get started. Get in on the fun while the bands are jumping with plenty of DX.

Of course if you are stuck with the ARRL's DXCC you have had it! You have just "worked yourself out of business" if you have been with the DXCC all these years. There just isn't anything on the bands that you need, so you can put a cover over your rig and go take a look at TV or go fishing. But there is a solution to your problems in the WTW. To qualify in the WTW competition all QSO's have to have taken place since 0001 GMT May 1, 1966. Now this puts lots of countries in the "rare" side of your ledger. I would estimate that well over 100 countries have not been on the air since May first. Is that not better than having maybe just one or two rare ones left like the DXCC? At least you have some DX'ing to do and that's better than 75 meter ragchewing or traffic handling. There is plenty for you to do if you like to work DX for the all new WTW DX award. Remember there are certificates for 100, 200, 300 and 350 countries, as well as a WTW for each band, and each mode. There is no mixing of the two or the bands, either. Everyone starts at the same point. The newcomers to DX'ing have the same chance as the old time DX'er.

Our country list is a reasonable list. It's made up of all the countries on ARRL's DXCC list plus a few that the Radiosport Federation of the USSR recognizes and a few others from the REF of France and the NZART. Others will be added when we hear from the other nationally recognized amateur societies of overseas nations. We are not including any countries just because we think they should be in the WTW list. All countries were suggested by others, not us. We don't want anyone to "button hole" us at some convention or gathering and ask us why such and such a place is a country, and such and such is not.

Of course if you are a tired, lazy, washed-out DX'er, the WTW is not for you. It's for the wide-awake fellow who wants to do something, one who is tired of just sitting in his shack twiddling his thumbs with nothing to do but gaze at his rig and yawn and go out to that TV set and gaze at it. You just keep on with the DXCC. It's your meat. The top fellows in the DXCC have nothing much to look forward to. Of course, they may need ZA or YI or maybe one or two others and with all the weekly DX bulletins you know if any of these will be on well in advance so there is absolutely nothing for you to do. The days of

call mode and band

name

address number of countries

List of stations worked (with date of QSO) in alphabetical order. This list can extend to the back of the card.

On the reverse: Name, call and signature of person submitting or verifying cards and date.

Please use this format (shown full size) for submitting applications for WTW award. Send to Gus, 73 Magazine, Peterborough, NH 03458.

"sneaking home" from work like back in the 50's has gone as far as the DXCC is concerned. But this can be done right now with the WTW. The WTW will bring back the "good old days" for all of you, even the newcomers. There is plenty of real good stuff on for the serious minded WTW DX'er—but not for the top boys in the DXCC. The DXCC certainly was a good deal for the boys a few years ago, but, fellows, those days are gone. This WTW is a modern-day DX'er's wish come true. Get in there fellows and join in on the fun. It's waiting there just for you.

We are gradually getting "verification clubs" lined up for the awards. We don't want any one to have to mail his QSL cards away from his continent, and in the case of USA hams we want to have a "verification club" in each call area. We still need a few to fill in here and there and are looking for volunteers yet in a few places. Any of you club members in the areas not yet covered, how about taking this up at your next club meeting and submit your club for consideration to me, c/o 73 Magazine. No individuals please—only recognized clubs. Here is a full break down on how we now stand:

Asia—We yet need one here
Africa—Also still needed
Oceania—Also needed
Europe—Via RSGB
South America—Venezuelano Radio Club, Caracas
Canada—Edmonton Radio Club
W/K1—Still needed.
W/K2—Still needed.
W/K3—Still needed
W/K4—Virginia DX Century Club (W4NJF)
W/K5—Still needed
W/K6—Orange County DX Club (W6KTE)
W/K7—Western Washington Radio Club (W7PHO)
W/K8—Still needed.
W/K9—Still needed.
W/KØ—Still needed.

We ask all verification clubs and hams to use a uniform method of submitting to me the information on the DX'ers who qualify. Please use the form shown. This will make my task a lot easier and we all will be using the same system of keeping records. I strongly suggest you keep a similar list on filing cards for future reference if needed. Note to verifying clubs: Be sure to return the cards to the sender, fellows. We don't want anyone accusing us of slow service, lost cards, stolen cards, and other type things that I have heard about some other awards that require QSL cards. Let's all really give the DX'ers fast service and no monkey business.

Will close this little article with a reminder: I shortly will start putting out a weekly DX magazine, The DX'ers Magazine. It'll help you keep right up to the minute on current active DX. Most of the good DX is past history by the time it's in a monthly magazine, you know. This is something entirely different—something that no monthly magazine can do. Let me hear from you. . . . Gus

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The Future of the 10 meter Band

The text of a talk given May 14 by 73's propagation columnist to the North Jersey DX Association.

About the 10th of April, 1966 I received a telephone call from Mr. Bob Stankus W2VCZ. He asked me in a very casual manner, as if there were nothing to it, if I would predict for the North Jersey DX Association the future of the 10 meter band. I did some quick thinking and realized immediately that in order to predict the future of the 10 meter band I also had to predict the future of the present sunspot cycle. I do not like to predict the sunspot cycle because after 20 years research on sunspots I have come to realize how whimsically the sun can behave. I also know from history that some pretty important astronomers and researchers had gotten into trouble working on this subject in the past—many of them knowing far more about the subject than I do. However, I considered the subject as a challenge and decided to see what I could come up with. I had quite a bit of data available on past sunspot cycles to use as research material.

First, I went into the history of frequencies near the 10 meter band in the archives of the RCA Frequency Bureau and found that RCA Communications started to experiment with 31 MHz which is of course slightly less than 10 meters, early in 1930. The experiments were conducted with Buenos Aires. RCAC using W2XS on 31420 KHz and Buenos Aires using LQB2 on approximately the same frequency. Unfortunately this was near the beginning of the 1930 sunspot low and the project had to be suspended until we got into the area of high sunspot numbers between 1936 and 1938. These frequencies were then run simultaneously with normal communications frequencies, which were on about 21 MHz and received on a dual tape recorder so that the messages that Buenos Aires was sending would appear, one above the other, on the same piece of wide tape. As an experiment the operators were ordered to copy the higher frequency whenever it was useful even though the lower frequency was still satisfactory. I further found in the archives of the Frequency Bureau that the amateurs were allocated the 28 to 30 MHz band in 1927 for experimental purposes according to the records of the Madrid Conference in 1932. So the amateur preceded the commercial stations in the investigation of this band. They proved its usefulness.

Since the early 1950's the receiving technicians at the RCA Communications receiving station at Riverhead Long Island have kept meticulous "two hour" records of the lowest and highest frequency readable from the European area. At the same time, they also record the quality of the signals in this band. I went through these records for the years 1955 to 1960 inclusive and determined the number of hours per day throughout the whole of each year that frequencies between 26 and 30 MHz were recorded as good. The data shown by these records is presented in chart A.

An examination of this chart shows quite

	1955		1956		1957		1958		1959		1960	
	A	B	A	B	A	B	A	B	A	B	A	B
Jan	0	20	4	70	134	152	234	202	208	217	76	139
Feb	0	21	0	123	94	117	148	165	172	143	88	103
Mar	0	5	4	116	72	167	106	191	186	186	80	103
Apr	0	11	0	105	14	175	24	196	42	163	4	120
May	0	29	NR	136	0	165	8	175	0	172	16	119
June	0	33	0	117	0	205	14	171	0	169	4	109
July	0	26	0	128	0	194	0	191	0	149	0	119
Aug	0	40	0	171	4	163	8	200	0	198	0	131
Sept	0	41	40	182	88	244	84	201	12	145	10	125
Oct	0	59	NR	161	122	263	220	181	48	111	8	81
Nov	0	90	146	203	212	207	230	152	44	124	38	87
Dec	0	77	172	185	194	233	184	187	66	125	34	83
TOTAL	0	452	366	1697	934	2285	1260	2212	778	1902	358	1319

A—The number of hours between 8 AM and 2 PM EST (1300 GMT and 1900 GMT) that frequencies between 26 MHz, and 30 MHz were logged as good from Central Europe at the Riverhead, Long Island, New York receiving station of RCA Communications, Inc.
B—The Zuerich monthly sunspot number.

Chart A. Comparison of sunspot numbers with stations received on 10 meters. Compiled by J. H. Nelson of RCA Communications, Inc.

dramatically the good correlation there is between the hours of usefulness of these higher frequencies and the yearly sunspot number. In 1955, with a yearly sunspot number of only 452, Riverhead logged no hours of usefulness on frequencies above 26 MHz. I would like to point out however that this does not mean that these frequencies did not break through occasionally since the technician does not keep a constant watch for them. He inspects the band every two hours on the hour. As we go into 1956, the yearly sunspot number increased to 1697 and the hours of usefulness rose to 366. In 1957 yearly sunspot numbers rose to 2285 and the hours of usefulness increased to 934. In 1958 the sunspot number stayed above 2000 being 2212 and the hours of usefulness increased to 1260. In 1959 the sunspot numbers began to drop showing a yearly number of 1902 and the useful hours of these frequencies dropped to 778. In 1960 the sunspot number dropped to 1319 and the hours of usefulness on these frequencies dropped to 358. In 1961 we find that these frequencies did not show up in the records at all although as I have said before there were probably occasional periods where they would have been heard if we maintained constant coverage.

I would also like to point out that these frequencies have very little or no usefulness during the summer months. They begin to show up in September and fade out in April. The data shows this very clearly.

The sunspot numbers that are shown here are the monthly averages. When these averages are smoothed into 12 month smoothed averages we find that the smoothed curve began with 14 in January 1955 and increased to 81 by the end of the year. In 1956 it began with 89 and ended with 164. In 1957 it began with 170 and ended with 200. In 1958 it began with 199 and ended with 180. In 1959 it began with 179 and ended with 132. In 1960 it began with 129 and ended with 84.

It appears that a smooth sunspot number in the neighborhood of 80 to 100 is necessary before these frequencies come to life. Data on this phase of the subject appears in Chart B.

Data on this chart pertains to sunspot numbers and sunspot cycles from 1755 up to 1964. It was analyzed in the following method in an effort to produce a technique whereby it might be possible to anticipate the trend of cycle number 20 which started in 1964.

I analyzed the sunspot records by several different methods before I came up with what is shown in this chart. Examination of past sunspot cycles indicated that low maximums were preceded by *prolonged periods of low minimums* and high sunspot maximums were preceded by *short minimums.*

Cycle	Low Year	A	B	High Year
1	1755	19	87	1761
2	1766	7	116	1769
3	1775	12	158	1778
4	1784	9	141	1788
5	1798	37	49	1805
6	1810	64	48	1816
7	1823	44	71	1829
8	1834	16	146	1837
9	1843	9	132	1848
10	1856	23	98	1860

Cycle	Low Year	A	B	High Year
11	1867	14	140	1870
12	1878	33	75	1883
13	1889	37	86	1893
14	1901	33	64	1906
15	1913	45	105	1917 (Short Peak)
16	1923	18	78	1928
17	1933	23	120	1937
18	1944	8	150	1947
19	1954	17	200	1957
20	1964	10	(135)	(1968)
Total		468	2064	
Average		24	108	

A—The number of months with a sunspot number of 10 or less during each low period.
B—The maximum smoothed sunspot number of the following high period.

	C	D	E	F	G	H
	19	87			37	49
	7	116	7	116	64	48
	12	158	12	158	44	71
	9	141	9	141	23	98
	16	146			33	75
	9	132	9	132	37	86
	14	140			33	64
	18	78			45	105
	8	150	8	150	23	120
	17	200				
Total	129	1348	45	697	339	716
Average	12.9	134.8	9	139.4	37.5	79.4

C—The low periods with 20 or less in column A.
D—The sunspot number in column B.
E—The low periods with 12 or less in column A.
F—The sunspot number in column B.
G—The low periods with more than 20 in column A.
H—The sunspot number in column B.

Chart B. Compiled by J. H. Nelson of RCA Communications, Inc.

After several different attempts I found that if I counted the number of months with a sunspot number of 10 or less during each minimum period I got the best correlation indicative of what the following high was going to be like. I won't go through this chart item by item but I would like to point out to you that in Column A we have listed the number of months that 10, or less than 10, sunspots were recorded, and in Column B is shown the maximum *smooth sunspot number* for the high period that *followed a few years later.* These data show quite clearly that the higher maxima were preceded by short low periods, and the low maxima were preceded by long low periods. This will become apparent to you when you study the chart closely.

On the lower section of the chart under Column C I have listed all the low periods that had *less than 20 months* duration and in

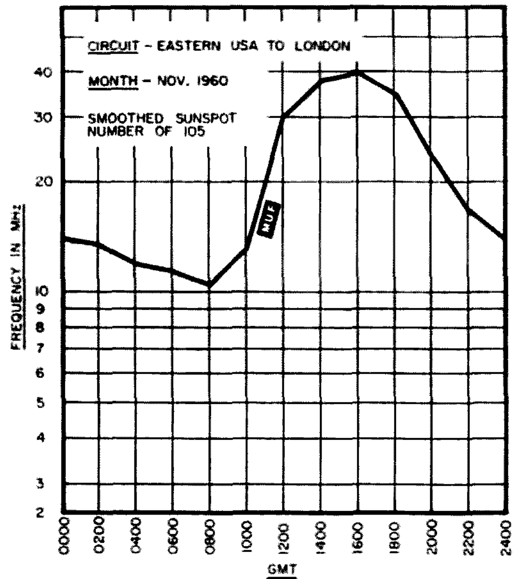

Fig. 1. MUF versus time of day, November 1960.

Column D I have listed the sunspot maximum associated with each of these periods. You will note that out of the 10 periods listed that had relatively short minima there were 8 with fairly high sunspot numbers during the following maxima.

In Column E I have been even more selective and picked out the periods that showed only 12 or less in Column A and here you see at a glance that these shortest periods of minima were followed by quite high maxima. The average lengths in months of these shorter periods was 9 months and the average sunspot maxima comes out to be 139.

If you would refer to the top of the chart and pick out cycle 20 you will see that Column A carriers the figure of 10 indicating that the 1964 low had 10 months with a sunspot number of 10 or less. A figure of 10 in Column A predicts a following maximum in the neighborhood of 135. This analytical technique therefore predicts that the sunspot number in 1968 or 1969 will reach a smooth sunspot number of at least 135 which should open the 10 meter band to Europe quite well from September to April.

Column G and H indicates that prolonged minimums were followed by low maximums. You can see from the data that when the average length of a minimum was 37.5 months, the average of the following sunspot maximum was only 79.4. Of the 9 items listed in Column G, seven of these items correctly predicted that a low maximum would follow. Two items were in error but not seriously.

To recapitulate, if we were to bet on a sunspot number to be high using the figures in Column C we would have been right 8 times out of 10. It we bet that a sunspot maximum was going to be low we would have been right 7 times out of 9 according to the figures in Column G. This particular approach indicates a strong probability that the figure associated with cycle 20 stands an 80% chance of being correct. But let me point out once again to you that I am not an expert in statistical analysis and this coupled with the fact that sunspot cycles are very difficult to predict causes me to warn you that I might be in error.

I have prepared two graphs that can be used as a further guide in anticipating the future. This first graph (**Fig. 1**) shows the type of MUF curve associated with a smoothed sunspot number of 105. It is for a circuit between Eastern U.S. and England. It can be seen from this graph that the most likely periods of the day for 10 meters (or 28 MHz) to be in operation are between 12 and 19 GMT in November. The next graph (**Fig. 2**) shows the November MUF for the same radio circuit based on a smoothed sunspot number of only 65. You will notice that this lower smoothed number predicted a MUF barely above 30 MHz. This indicates that somewhere between a smoothed number of 65 and 105 the 10 meter band is going to become operational. This figure is probably close to a smoothed sunspot number of 80 which should appear during the 1966-67 winter.

The statistics presented and analyzed in this report predict that 10 meters should come to life, at least spasmodically, between U.S.A. and Europe during the coming winter (1966-67) and should be well established by the following winter. . . . Nelson

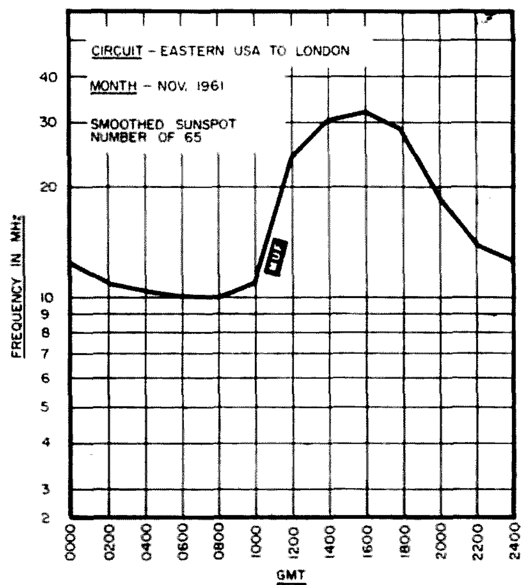

Fig. 2. MUF versus time of day, November 1961.

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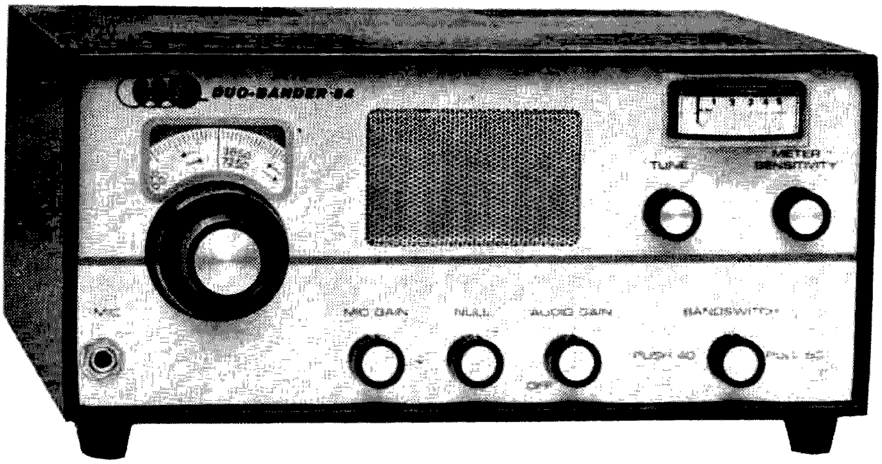
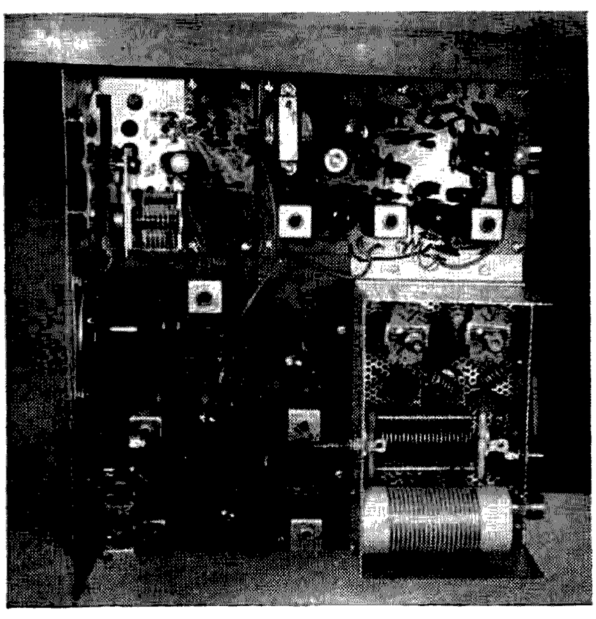


WRL Duo-Bander 84

For a long time I have been spoiled by using a transceiver in the car and the boat, to the point where the transceiver was always being taken into the house. The separate transmitter and receiver were such that it was impossible to make into a transceiver combination. When World Radio Labs announced the Duobander 84 at its low price this seemed to be an ideal way to eliminate taking the rig out of the car and hauling it into the house or, if it was on the boat, hauling the set and the AC power supply from the boat to the car and then into the house.



The specs in the ad seemed too good to believe for the money (only $159.95), but one was ordered. It is sometimes more fun to order and wait, than to buy off the shelf. This way you get double pleasure; first, the placing of the order, then the anticipation while waiting for it to arrive.

As soon as it arrived it had to be put on the air and, in spite of a large card on top of the set saying "please read the instructions before you send it up in smoke," I had to hook it up and see how the receiver worked. 80 meters was tried first, and the velvet-smooth dial and the wide 2 kHz divisions were a real pleasure to use.

The urge to transmit was great, but I decided at this point that I was not as smart as the book—so the instructions were followed, and it was on the air in a few minutes. The tuneup was the ultimate of simplicity: Adjust the bias; tune; null the carrier and set the mic gain (with the aid of the large edge reading meter); then go. The 300 watts PEP sure

looked big on the monitor scope and from the reports it looked big on the other fellow's S-meter.

The next step was to start studying the instruction book to see where all this signal was coming from and how it was being produced. At the same time the top and bottom of the set were removed for a good look inside. The first impression was that here was a very nice piece of workmanship, a layout that would be easy to service, and that all the parts were first line quality merchandise; no skimping here.

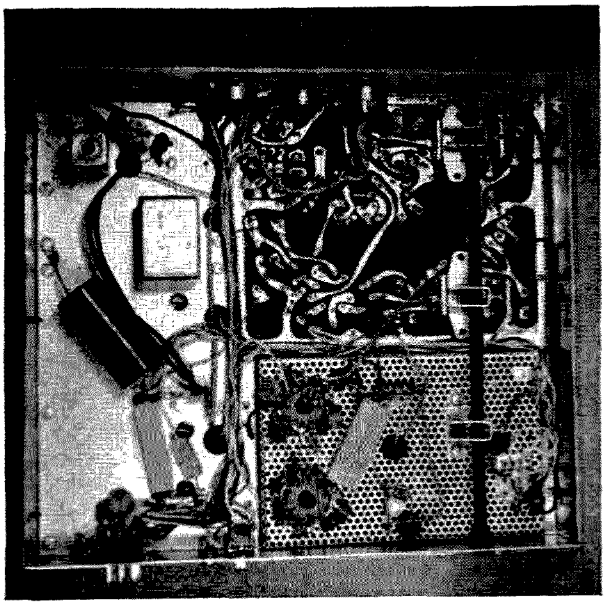
The study of the instruction manual revealed that there were seven transistors, nine tubes and four diodes. An interesting thing here is that two of the diodes are actually transistors and are being used just like K9VXL says to do in the July 1966 issue of 73 Magazine. All of the transistors are the same type, so if you like to have spares you only need one.

As is standard with any sideband equipment, this transceiver is of the mixing type. The choice of frequencies is a good one. First the turnable oscillator is quite low (1.55 MHz to 1.75 MHz) which, with the use of transistors, makes a very stable oscillator. Now since this is a set that works on 75 and 40 meters, it can quickly be seen that the right choice of *if* frequency would allow the oscillator frequency to be added to get on 40 meters and subtracted on 75 meters. The *if* frequency is 5.5 MHz. The use of a McCoy 4 crystal lattice filter gives the desired selectivity and unwanted sideband rejection.

A very clever band switching arrangement has been worked out using slide switches. A bar with fingers moves the three slide switches from 75 to 40 meters. This method of switching allows very short leads, and then there is a space savings.

Since this transceiver only tunes 200 kHz, the band pass tuning coils are slightly broadbanded so that they do not need to be tuned when going from one end of the band to the other. The coils are shunted with resistors and a portion of the coil is shorted out when going to 40 meters. Each stage has two coils so that the band pass can be fairly wide with steep enough sides to eliminate harmonics and spurious radiation.

One thing that impressed me was the fact that the parts list showed prices. This in itself is not so special, but here all the prices are shown even for special items—and the prices are net and not inflated prices. These prices are the same that you would pay in any radio store. And the prices of the special items like



The final amplifier uses a pair of 6HF5's. These tubes have a very high plate dissipation to start with, and Sylvania tells us that in amateur service they can be up-graded 30% to a total of 36 watts. These tubes also have the advantage that they will handle a fantastic amount of current because of the design of the plates. If you check the tube manual you will find that these tubes will handle 900 volts at an average cathode current of 315 mA which comes out over 280 watts each, so they just loaf along with only 300 watts PEP on two of them.

To really find out what this new transceiver was doing, Ray Abair K8NBQ and I took it over to Rowe Industries to check it out with all the nice test gear that they have. Here is what we found, using a single tone signal at 2000 Hz:

Transmitter:	
Power output	160 watts PEP
Carrier suppression	43 dB below peak output
Unwanted sideband	41 dB below peak output
spurious output (2 tone sig.)	29 dB below peak output
Oscillator drift	Negligible
Receiver:	
Sensitivity	0.45 μV for 10 dB S/N
Selectivity	2.7 kHz at 6 dB down
	6 kHz at 60 dB down
Image & *if* rejection:	43 dB

The picture shows the small size of this transceiver which should make it a swell rig for mobile work. The small size will allow it to fit into the car in several ways. Dollar for dollar, you will have to look a long way to find so much transceiver for under $160; and it comes ready to operate. Just a little over 50¢ a watt.

. . . W8QUR

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The RF Discriminator

Here are some useful applications for a little-known circuit.

The rf discriminator is potentially one of the most useful of receiving accessories. Unfortunately, its use among hams, other than in an occasional VHF-FM receiver, is rare. This may be due to the lack of information available in amateur publications on the possibilities offered by this device. Some of these applications as a receiving aid for modes other than FM will be discussed here. Rather than go into details of operation or construction, which are adequately covered elsewhere, [1, 2, 3] this article will be concerned only with some of the wide variety of applications to which a discriminator can be adapted.

Perhaps the greatest use of this circuit is as a "locking" device to keep a station centered in the receiver passband. **Fig. 1** is a block diagram for this application. With the VFO tuned so that a signal is centered, the discriminator output is zero. If either the VFO or the applied rf signal tends to drift, the discriminator output applies a correction voltage to the VFO (which must be equipped with a varactor or similar electronic tuning capability) which tends to correct for the drift. The extent to which the correction is made depends on the slope of the discriminator characteristic and the sensitivity of the VFO. Specifically:

$$\Delta f_2 = \Delta f_1/(1 + KA)$$

where: Δf_1 is the change in rf frequency applied

Δf_2 is the resulting change at the *if* frequency

K is the slope of the discriminator characteristic in volts/kHz

A is the electronic tuning sensitivity of the VFO in kHz/volts

Fig. 2 is the circuit of the limiter-discriminator (designed by WA6BLX) in use here. The two stages of gain preceding the output stage insure that V_4 runs completely drive-saturated class C, and thus is AM-insensitive. The measured limiting threshold of this circuit is about 10 mV. With the transformer and voltages shown, the measured slope of the output curve is 2.4 volts/kHz. The dc varactor voltage must be sufficient to insure that the varactor is always reverse biased and both that voltage and the plate voltage must be well regulated, since either will modulate the output. S_1 allows the voltage fed to the varactor to be filtered to any degree desired independently of the other outputs.

Fig. 3 shows the common way to provide for varactor frequency modulation of an oscillator. It is far less cumbersome than a reactance-tube modulator and has the capability of far higher deviation sensitivity. The exact sensitivity can be varied by varying the bias voltage, the coupling capacitance C_c, or the varactor.[4] The particular circuit in use at K7DEP has a sensitivity of about 10 kHz/volt at 3 volts bias and this figure will be used in the examples below.

In its most basic application, this circuit is a very good NBFM detector. Running open loop (S_2 in **Fig. 1** open) it will give 2 volts rms audio for a 1.5 kHz deviation.

In the VHF bands, wide-band FM does enjoy some deserved popularity: Modulation is a low-level process, signal generation is easier than for SSB, and all amplifier stages run at class C efficiency. The problem is reception, which requires a wide *if* bandwidth and wide discriminator. If, however, we close the loop

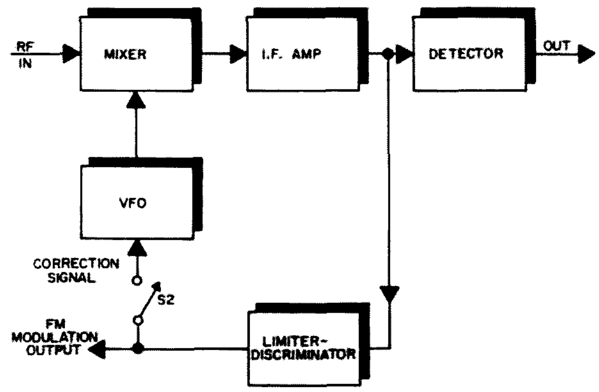

Fig. 1 Block diagram of a simple locking (automatic frequency control) system for a receiver.

with a correction signal which will follow the instantaneous carrier frequency, the modulation will be effectively narrowed by the factor $1/(K + KA)$ as calculated above (about 25 for the circuit discussed). Thus a 12.5 kHz deviation FM signal is reduced to 0.5 kHz in the *if* strip and to about 0.3 volts rms of audio at the FM output. Also, since the discriminator is dc coupled to the varactor, any long-term drift of either receiver or carrier will be reduced by the same factor as the modulation. Note that the same discriminator performs all three functions of bandwidth reduction, frequency locking, and detection simultaneously.

The problem of carrier and local oscillator stability becomes more serious as frequency increases. This is especially true of receivers which tune entire VHF bands in one pass. With a 10-15 kHz bandwidth, a little drift isn't too noticeable, but with a 500 Hz CW filter it can be disastrous! By running closed loop, we can easily reduce the drift to almost any degree desired. By employing a very long time constant in the correction signal path, loss of lock between CW characters can be avoided. All this allows the use of near-optimum *if* bandwidths for AM, CW, and, as we shall see, possibly even SSB.

For the serious VHF'er for whom stability is no problem, the discriminator offers an added bonus in measuring doppler shifts. By running open loop and monitoring the dc output on a VTVM (or better still on a chart recorder) 30 Hz of carrier shift can easily be read. Since observed shifts on OSCAR have been of the order of 6 kHz, this is adequate for most work. If a chart recorder having a dc

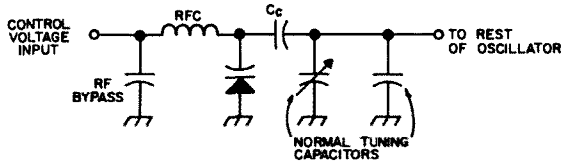

Fig. 2. The limiter-discriminator designed by WA6BLX used by K7DEP. It will keep your receiver tuned to the station you're working even though the other station drifts slightly across the band.

offset capability is used, then even greater sensitivity is possible.

In a completely different field of interest, the rf discriminator provides one of the easier, though admittedly not one of the best, ways of receiving RTTY. Running open loop, the discriminator in **Fig. 2** puts out just over two volts difference in dc level from space to mark with standard 850 Hz shift. This could be used to drive a keying tube directly or, for better reliability, used to switch a Schmitt trigger[5], and that in turn could drive a keyer in the machine local loop. A very simple arrangement of this type could be a realistic answer to the casual RTTY operator who doesn't want to invest the time it takes to build a complete audio converter-terminal unit. Incidentally, if a single VFO is used for receiving and transmitting, as is becoming increasingly common today, then that varactor is already there for FSK transmission, requiring less than 0.1 volts drive for 850 Hz shift.

Another possible use for the discriminator, and the one where it is needed most, is as a SSB tuning aid. With one of the better receivers now on the market, it is relatively easy

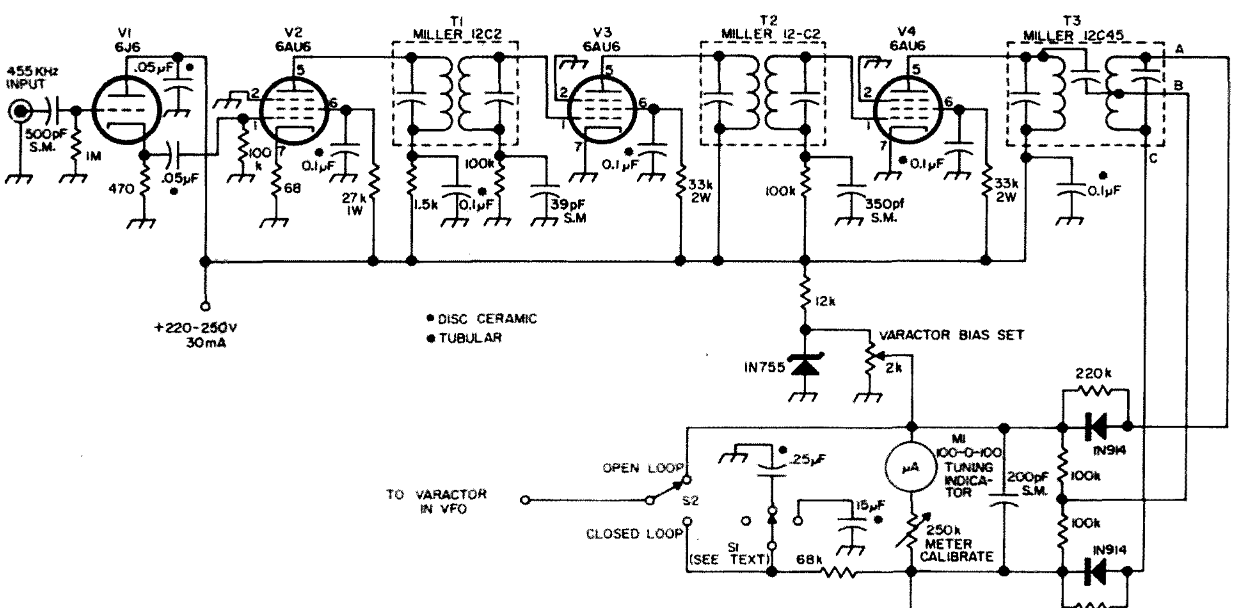

Fig. 3. The common varactor frequency control that is applied to transmitter or receiver VFO's.

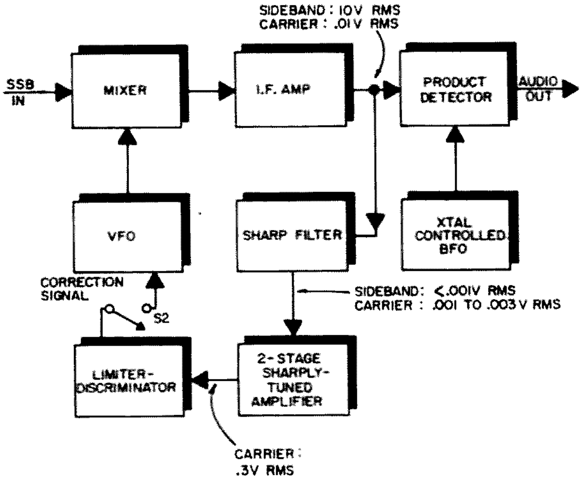

Fig. 4. Correction system to keep SSB stations tuned in properly. This is especially nice in round tables.

to tune sideband to readable fidelity. But for truly natural sounding speech, the reinserted carrier must be within 10 Hz of the suppressed carrier.[6] Not only is this difficult, but with more than two stations in the QSO, it requires constant BFO juggling.

The system in common commercial use separates the suppressed carrier from its sideband and re-amplifies it to a usable level. Then it is fed to the discriminator which provides a correction signal to the VFO to "lock" the receiver on the carrier as described above. All this will require two additional components besides the basic limiter-discriminator. The first is a sharp filter detuned slightly from the *if* center frequency (assuming that the sideband is centered), and the second is some additional amplification between the filter and limiter stages. More specifically, if we assume that the received carrier is 60 dB below the average sideband level at the *if* output (this may seem pessimistic, but remember that the carrier may be part way down the skirt of the *if* characteristic), then the sharp filter should be at least 60 dB down at twice the lowest audio frequency transmitted (usually 300 Hz). The additional amplification is to elevate the carrier to well over the limiting threshold. Two stages of gain should be sufficient. **Fig. 4** shows this process. Since the only critical component is the sharp filter, this system is quite feasible for ham use. Using this mode of operation, several stations in a single QSO will all lock if they are within ± 250 Hz. Also, since 10 Hz is below the limit of most receiver audio systems, easy exalted carrier reception of AM is provided for under the same conditions as SSB, but without the necessity of the extra amplification and filtering.

A lot of fuss and bother that isn't really necessary? Perhaps, but that is what makes the difference between "good enough for amateur" and truly professional quality.

. . . K7DEP

[1] "Specialized Communications Systems," **ARRL Handbook**, 1961, p. 329-330.
[2] Allen Katz, "UHF Roundup," **CQ** (April, 1964), 79-80.
[3] Ralph W. Burhans, "An IF Tracking Filter for Weak-Signal Reception," **QST** (September, 1964) 11-17, 166.
[4] R. E. Baird, "Something New in Frequency Modulation," **73**, (October, 1960), 10-11.
[5] Jim Kyle, "Understanding the Schmitt Trigger Circuit," **73**, (March, 1965) 74-78.
[6] Terman, Frederick E., **Electronic and Radio Engineering**, (New York, 1955) pp. 957-958.

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Amplitude Modulation vs. the Carrier

Some easy-to-understand proof that a carrier is not affected by amplitude modulation.

The statement is often made in the study of amplitude modulation that the actual carrier *does not* change in amplitude during the modulation process. Many an old time AM ham will raise his eyebrows in horror; however the statement is true. We have all looked at the pattern of modulation on an oscilloscope using a linear sweep. If 100% prevails we note that the pattern varies from zero amplitude on 100% negative peaks to twice the amplitude of the carrier at 100% positive peaks. Hence the carrier amplitude varies. T'ain't so chum! You forgot what you were looking at and what the oscilloscope sees. The oscilloscope sees the complete rf signal. And the complete rf signal is made up of a carrier and two sidebands. The scope sees them all at once and gives you the composite picture. If you had a very selective circuit that would tune in the carrier and reject the sidebands you could look at the carrier all by itself. What you would see would be a nice smooth carrier that does not change in amplitude no matter where you set the modulation volume control.

At about this point in the discussion some joker in crowd says, "What will happen if you over-modulate and a 100% negative peak is maintained over a considerable period of time? Since there is no power during this period there can be no carrier. Surely this is too long a time for the flywheel of the tank circuit to maintain the carrier without damping out." Well believe it or not the original statement is still true. The carrier is still there and does not vary in amplitude during the process of modulation. This is a very difficult thing to explain physically. Let us try and see if we can explain this seemingly impossible situation.

First of all let us hasten to agree that the flywheel effect will damp out very rapidly if a circuit is loaded at all. **Fig. 1** is an oscilloscope pattern of the output of a frequency tripler which is loaded to some extent. There is a plate current pulse every third cycle. It is evident that even in three rf cycles the degree of damping is quite measurable. Secondly, the decision was made to set up the worst possible example of negative peak modulation possible, and observe the results. Therefore a demonstration type rf amplifier driven by a crystal oscillator was adjusted so that it would be di-

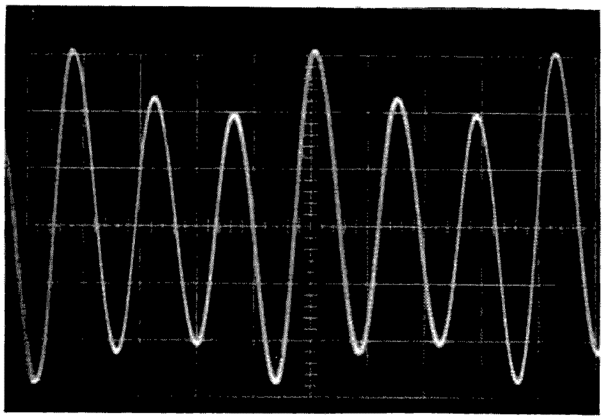


Fig. 1. Output of a frequency tripler.

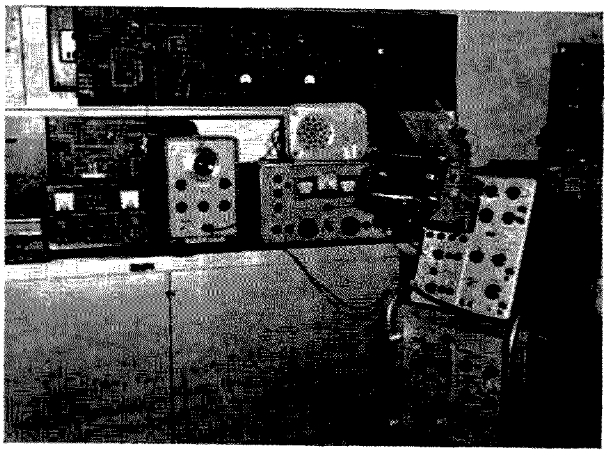


Fig. 2. Entire experimental set up.

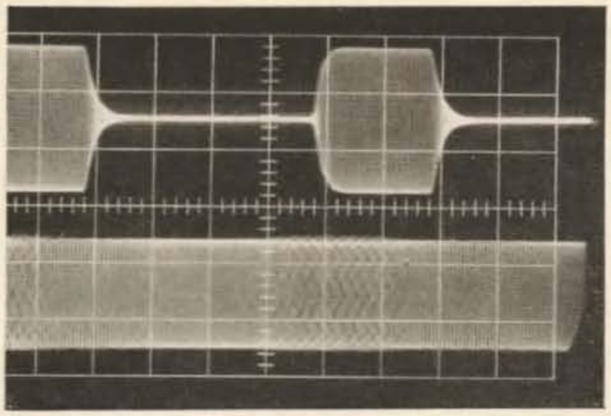


Fig. 3. Upper-modulation pattern from transmitter. Lower-carrier pattern (455 kHz) observed on HQ 160 receiver. Both viewed simultaneously. Moire on carrier caused by double pattern on scope.

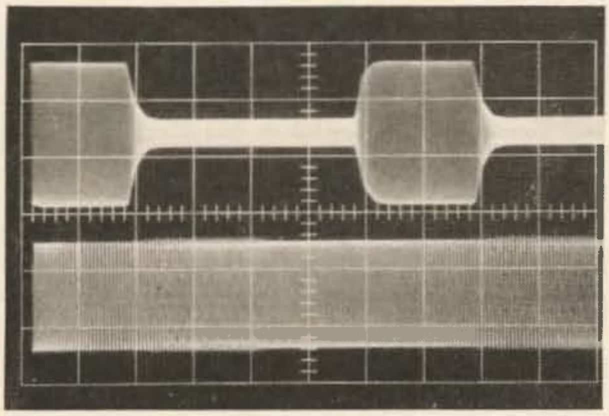


Fig. 4. Same as Fig. 3, but with less modulation. Note constant carrier amplitude in Figs. 3, 4 and 5.

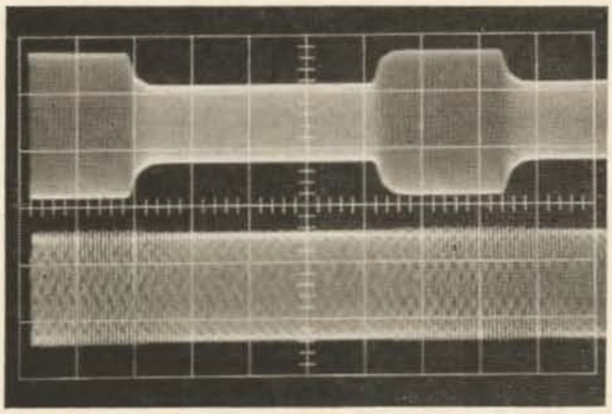


Fig. 5. Same as Figs. 3 and 4, but with less modulation.

rect modulated by a square wave generator. The signal was picked up by a Hammarland HQ 160 receiver sufficiently isolated from the crystal oscillator so that the carrier of the amplifier as observed at the 455 kHz *if* was much larger than that of the oscillator. The *if* of the HQ 160 was fed into a Tektronix 545 scope. Using 10 kHz square wave audio as a modulating signal, it is possible to observe the

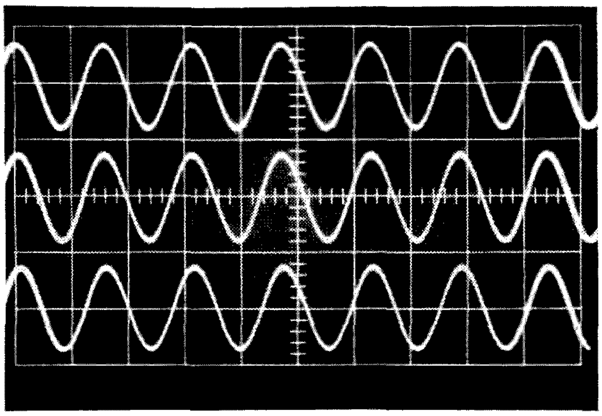


Fig. 6. Upper sideband, carrier and lower sideband. Taken in three exposures. Pattern moved and HQ 160 tuned for each exposure. See text.

carrier without either sideband or to observe either sideband without the presence of the carrier or the other sideband, when the receiver is adjusted to its sharp tuning position. The complete setup is pictured in **Fig. 2.**

Fig. 3 shows the modulation pattern coming out of the modulated amplifier, in the top portion, while the bottom pattern displays the carrier simultaneously (as viewed at the 455 kHz *if*) tuned in on the receiver. These two patterns were scoped simultaneously with the scope being triggered on the square wave. This results in a noticeable moire effect on the carrier display which disappears if the carrier is viewed without the second pattern being present on the scope. It should be pointed out that the period of nothing but center line in **Fig. 3** is on the order of 40 microseconds. Since the carrier frequency is about 4 MHz this would amount to time for 160 rf cycles, much longer than the flywheel could possibly maintain the oscillation of the tank circuit. *So the carrier is really there!* As can be seen from the figure the amplitude of the carrier does not change during modulation nor does it come in bursts. **Fig. 4** and **5** show the same conditions at less than 100% modulation. (Amplitude was adjusted at the scope to give the right size for making pictures). **Fig. 6** shows the upper sideband, the carrier and the lower sideband with the time base on the scope so that you can see the individual rf cycles. Note the nice wave shape and no evidence of damping. The picture was taken as a triple exposure rather than simultaneously. The upper sideband was tuned in first on the HQ 160 and positioned in the upper third of the scope, then snapped. The carrier was then tuned in and positioned in the center and snapped. Lastly the lower sideband was taken. So the pictures do not represent a simultaneous action and the relative phase is meaningless. They all look alike because a half dozen cycles of 3980 kHz practically match a half dozen cycles of 3990 or 4000 kHz. If you look at either sideband by itself and vary the modulation, of course the amplitude changes. With no modulation there will be no sideband at all and it will increase in amplitude as the gain is turned up. The carrier when viewed alone changes not at all regardless of where you set the gain control.

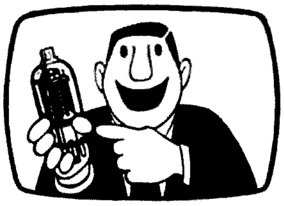
Non-mathematical explanation: It is true that during the negative peak we do have a total of zero power. But the factors that add up to zero are not zero themselves. The carrier is one of these factors. Also even those not mathematically inclined will agree that a square wave or any distorted wave can be broken down into a series of sine waves. Anybody who has ever operated a wave analyzer knows this. So why should a square wave yield anything different than multiple sine wave modulation? Don't forget the oscilloscope sees all of these frequencies at once when connected to the modulated stage and shows you the composite sum.

An interesting observation: A side observation of this experiment with square wave modulation with the carrier frequency of 3990 kHz was that it was possible to observe sidebands every 10 kHz for at least 400 kHz either side of 3990. This was a very impressive demonstration of why overmodulation causes "buck shot" the width of the band.

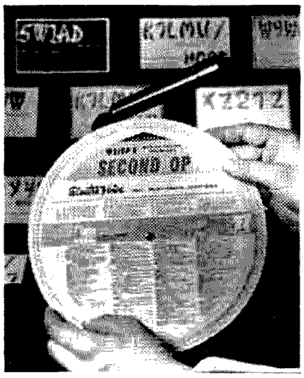
Once again, the amplitude of the carrier does not vary with amplitude modulation. The amplitude of the entire signal (composed of carrier and sidebands) does vary from zero to twice the amplitude of the carrier by itself with 100% modulation.

Hope this doesn't give you old time AM boys a nightmare!

. . . W7CSD

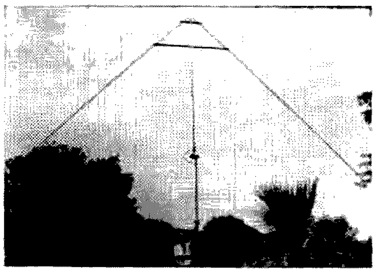


NEW PRODUCTS



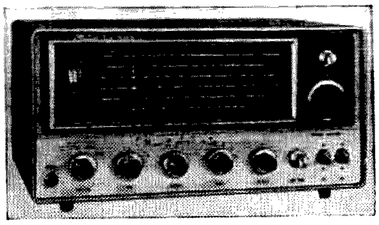
Revised Second OP

Band conditions are improving every day, and Electro-Voice has just published the new, fully-revised, fourth edition of W9IOP's Second Op. This well-known operating aid of durable, laminated card stock is actually a simple DX computer providing vital data such as beam headings, identification of prefixes, time zone, continent, and postage rates. Included also on the periphery of each Second Op are provisions for logging contacts and receipt of confirmation. You can get your new Second Op for $1 from Electro-Voice, Department PR-73, Buchanan, Michigan or from your Electro-Voice dealer.



Super "Q" Roto-V Antenna

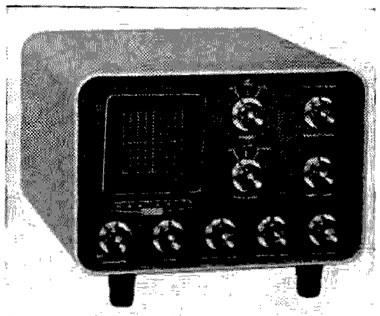
Super "Q" Products has just brought out a rotatable inverted V antenna for 15 or 20 meter operation. It is constructed from aluminum tubing with telescoping end sections so that it can be used on either 14 or 21 MHz. The manufacturer states that when the antenna is tuned up for operation on 14.275 with an SWR of 1:1, the SWR at 14.350 is not greater than 1.3:1. Since the input impedance of this antenna is 50 ohms, it can be fed directly with RG-8/U coaxial line and no matching devices are needed. The lightweight construction of this antenna features heavy polystyrene insulators which hold the tubing in the proper position and clamps that will fit any mast up to 1½ inches in diameter. The radiation pattern is bi-directional and attenuation off the sides of the antenna is approxiamtely 15 dB. The low center of gravity of this design and its light weight simplifies the problem of rotation since a small, light-duty TV rotator is more than adequate. Tests in windstorms have shown no signs af strain in winds up to 75 mph. The Roto-V is available express or truck freight collect for $29.95 from Super "Q" Products, Box 8405, 5704 South Staples, Corpus Christi, Texas 78413.



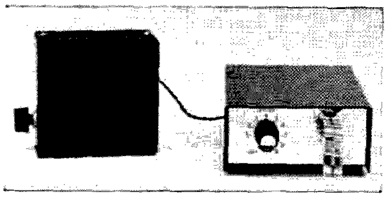
Lafayette HA-500 Ham Receiver

The new Lafayette HA-500 ham band receiver tunes the 80 through 6 meter amateur bands in six tuning ranges. It's a 10-tube double conversion superheterodyne. Among its features are tuned rf and first mixers, two mechanical filters, product detection, "always-on" oscillator filament, built-in 100 kHz calibrator, illuminated slide-rule dial, S-meter, automatically switched AGC for AM or SSB, and less than 1 μV sensitivity. Size: 15″ W x 7½″ H x 10″ D. Price is $149.95. Write Lafayette for more information at 111 Jericho Turnpike, Syosset, L.I., N.Y. 11791.

Heath SB-610 Monitor Scope



The newest member of the Heath SB-Series is the Heathkit SB-610 Signal Monitor for both transmitted and received signals. It displays actual signal envelopes or trapezoid patterns from transmitters, and it will give an equally complete picture of signals being received. It can be used with low or high power transmitters from 160 to 6 meters and with receiver *if's* as high as 6 MHz. Price is $69.95. You can get complete information on the SB-610 from Heath Company, Benton Harbor, Michigan 49022.



Trans-Key Electronic Keyer

The new Trans-Key transistorized electronic keyer offers either automatic (self-completing dots and dashes) or semi-automatic or "bug" operation (not-self-completing). This unit is completely battery powered and does not require connection to 110 volt lines. It has relay output so there are no worries about voltage polarity or method of keying your transmitter further, it is fully adjustable from a few words per minute to over 50 words per minute and features an adjustable dot-space ratio. Since it only requires 10 to 15 mils of current, the battery supply has a very long life. $29.50 from your local distributor or write to W6PHA, Global Import Company, Box 246, El Toro, California.

Motorola IC Projects

Integrated circuits (IC's) are finding rapid acceptance and varied application in industry today. The new book *Integrated Circuit Projects From Motorola* brings these useful devices into the grasp of hobbyists and experimenters. Because integrated circuits are the basic component of each project, the book begins with a brief explanation of IC theory and a definition of terms. The second chapter includes construction techniques and a pin location chart for those not familiar with solid state components. Six projects are fully described including, among others, an electronic organ, a binary computer, and a square wave generator. Each project begins with a brief circuit description, lists all the parts needed, and leads the builder through a step by step construction of the project. Schematics and drawings of the recommended layout are included as an aid to the builder. Testing and operation procedures complete each presentation. Available for $1 from your local Motorola HEP distributor. Motorola, Inc., Box 955, Phoenix, Ariz. 85001.

Motorola Solid State Projects

Eight projects for hams and experimenters are collected in the new book, *Solid State Projects From Motorola.* Hams might like to build such projects as a deluxe CPO, audio signal generator, regulated ten volt power supply, or six meter converter. Experimenters might enjoy duplicating the panic button, mini-fi transistor amplifier, intercom system, or motor speed control. All are clearly and completely described. Each project includes pictures of the finished product, layout diagrams and schematics, as well as a complete parts list. The projects are described in enough detail that even the beginner to electronics could complete them. To help those not familiar with the workings of semiconductors, a chapter at the beginning of the book provides basic theory. If one has not soldered semiconductors before, or isn't sure of the correct pin connections, he has no cause for alarm, as both are covered in the chapter on builder's hints. All use Motorola HEP transistors. The manual is available for just 50¢ from local HEP dealer. Motorola HEP Program, Box 955, Phoenix, Arizona 85001.

RCA Linear IC Handbook

RCA has just released a new book concerning IC design and applications entitled *RCA Linear Integrated Circuit Fundamentals.* This new manual, the first of its kind in the industry, is written primarily for equipment and system designers, but is of interest to anyone concerned with this new field in electronics. The first chapter is about general design considerations followed by basic configuration of the linear IC and of the operational-amplifier, and finally characteristics and applications of IC's. In the last chapter (applications) the basic family of IC's (differential amplifiers) is fully described. Dc, audio, video, *if*, rf, and operational amplifiers are covered. This last chapter includes more than half of the book, and appears to be the section most likely to be referred to by hams. Circuit diagrams, operating characteristics and performance data are liberally included throughout. Hams interested in keeping abreast of this rapidly expanding field would do well to invest $2 in this fact-packed book. Copies may be obtained from RCA distributors, or from Commercial Engineering, RCA Electronic Components and Devices, Harrison, N. J. 07029.

Motorola Microwave Designer's Data

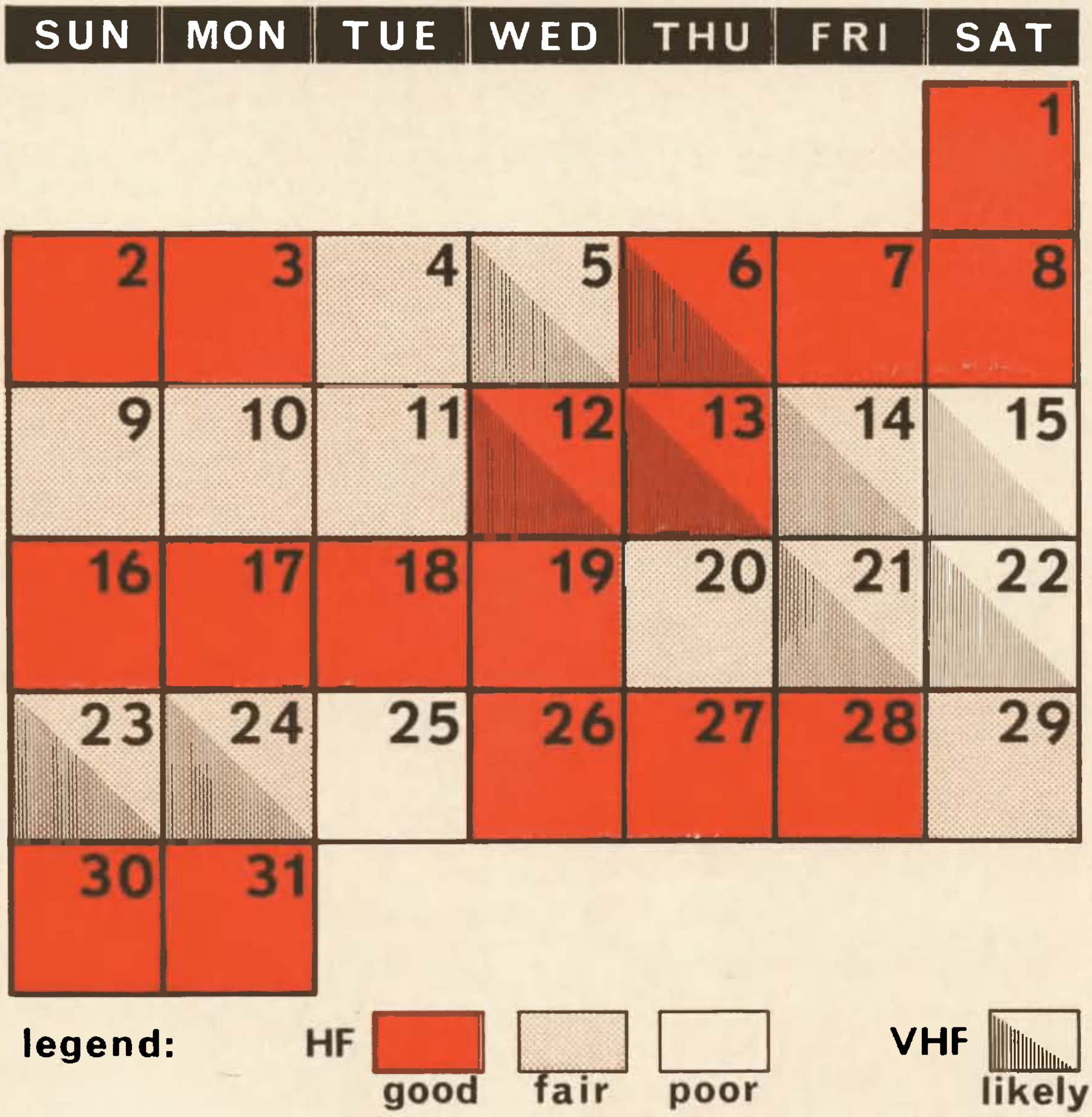
Designers who work with microwave should make sure that they get Motorola's Microwave Designer's Data Manual. It contains application notes and spec sheets on Motorola Epicaps, varactors, and rf switches. Write on your company letterhead to Motorola.

PROPAGATION

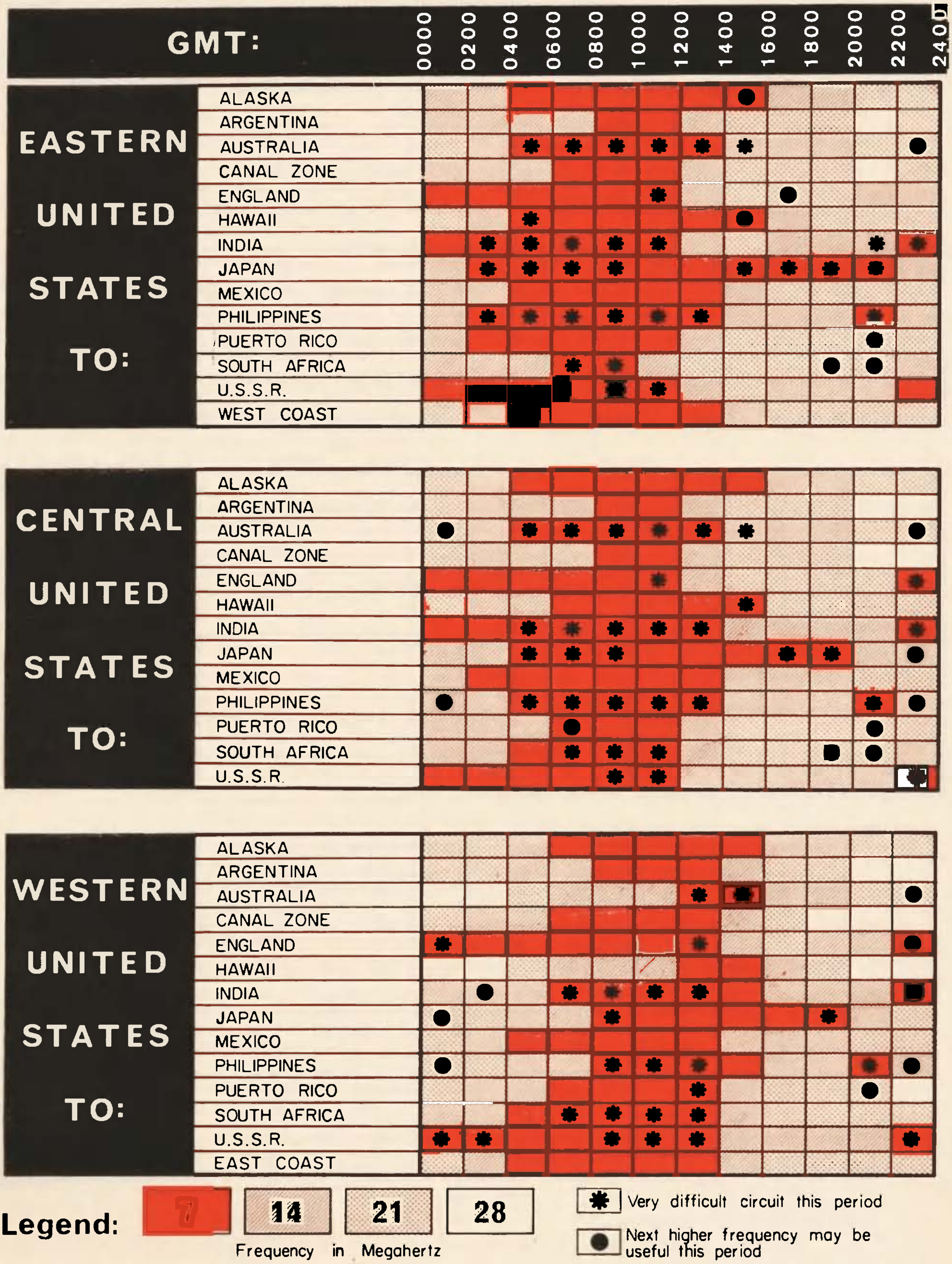
OCTOBER 1966

J. H. Nelson

DX CALENDAR



OPTIMUM FREQUENCIES HOURLY



Letters

Oscillator Error

Dear 73:

The schematic of the six volt oscillator on page 40 of the August issue is in error. On P2, the plug for 12 V, there should be no connection between pin two and the jumper connecting pins one and three. The plug as shown in the article would burn out the tube filament as soon as it was connected.

Don Marquardt K9SOA
Gary, Indiana

It Hertz

Dear 73:

I am not the type to go around complaining and protesting about everything on principle. But every now and then something gets me quite upset and makes me feel obliged to speak my piece.

When I read in the May issue that you were converting from cycles to hertz, my reaction was "He's joking: or at least, he won't start for about ten years." However, having now looked through the June issue, I see that you mean business. And I would, therefore, like to register my objection. If you want to turn 73 into a crusade for international cooperation and unity, why stop with Hz? You should certainly use European schematic symbols and tube designations, and while you're at it you could publish the whole magazine in Esperanto.

Forgive the over-dramatization, but what I'm getting at is this. Official government policy notwithstanding, a switch from cps to Hz in a magazine like 73 should **reflect** such a switch on the part of its readers; it should not be done to try to extort such a switch from them.

I am 18 years old, and for the foreseeable future, I for one shall stick with good old cps, in writing and speaking, unless and until I be convinced that a change to Hz for internal American usage has been about 95% accepted; at which time I would yield to the majority. I do not, however, believe that such a point has been reached, nor do I believe it to be the proper role of your magazine to push it.

When I see Hz, kHz and MHz in place of cps, kc and Mc, particularly in a strictly domestic publication, let me tell you, it hertz.

Alan Goott K3UOU
Silver Spring, Md.

Compliments

Dear 73:

Congratulations on your informative and interesting magazine. As an electrical engineer and builder of my own equipment, I am particularly enthusiastic about your construction articles. They incorporate "state of the art" methods in projects worthwhile to the amateur.

I would like to see more reference type articles such as the one on coaxial transmission lines in the July issue. Good work!

Dean Farrish WB4DAS/DL5LW
HDQ, Seventh Army Signal Section

Dear 73:

July '66 issue—the most diabolical cover(s) yet!! I pick the damn thing up upside down everytime!!!

And I won't even mention Batham—even upside down: sick, sick!

Swell solid state articles, though. You're on the beam with the latest scoop in that department.

John Anslow WA6DPJ
San Francisco, California

The design used in the cover is by WA4VAF and WA4-WOL. Somehow that got left out of the July issue. Paul.

Dear 73:

My compliments to you for that April issue. Since we all read **Playboy** (who doesn't) even the non-hams get a laugh out of it. Keep up the excellent work. Even though we can't operate from here, your magazine is well read and discussed by quite a number of hams, non-hams, technicians, tech reps, etc., at this location.

Arv Evans K7HKL
Viet Nam

Dear 73:

Just a quick note to congratulate you on the evolutionary path your magazine is taking. The vast number of articles per issue and the up-to-date subjects have, in my opinion, considerable appeal. Of great importance is the **mix** between construction articles and information articles (origin of the code, explanation of RTTY). 73 started out with an image of "How to do it," but appears to be broadening lately. Good! For pete's sake fellows, don't let it go too far in any one direction.

The April issue was particularly clever. The Playboy theme is timely and was well satirized by K3SUK's illustrations.

Keep up the good work.

A. Schechner
Philadelphia, Pa.

Micro-Ultimatic

Dear 73:

Since publication of the "Micro-Ultimatic" article in your June issue, I have received quite a bit of correspondence and am pleased at the number of CW hams who have built the keyer. There are several questions many letters have in common. Also there are a few suggestions which I feel would aid in the construction and debugging of the keyer. Therefore I am writing to help those others who may not yet have written me.

First, I must apologize for implying an identity in performance between the Micro-Ultimatic and Kaye's original Ultimatic back in 1955. There is a fundamental difference in performance between the two keyers, and that is this: With both key paddles closed at the same time, the Micro-Ultimatic will generate a string of alternate dots and dashes. This is normal. The 1955 Ultimatic does not respond the same way. I thank K6LTS for the question which brought this difference to light.

An improvement in performance is had by raising the output capacitor in the power supply to about 1000 μF. With the 200 μF in the original schematic, 120-Hz ripple was excessive and caused the pulse generator to tend to lock to subharmonics of the ripple. This had the effect of making the keyer "prefer" certain operating speeds.

There seem to be no errors in the article as published. Several hams have written me to describe their success in building and operating the keyer. This is somewhat unusual, since most letters would be from builders who are having trouble.

It is quite important that no rf energy get into the keyer. The usual shielding and filtering practices are called for. Make sure that the keying output to the transmitter is not a path for rf energy. A low-pass filter cutting off around 100 Hz and mounted *at the transmitter* was required in one stubborn case.

A few cases of defective integrated circuits were reported. Fairchild makes a practice of replacing these dead-on-arrival units through their distributors at no charge, according to a friend of mine. So the builder needn't despair if his $4.00 flip-flop doesn't work. The IC's can be ruined however, by inadvertent application of B+ to any output lead if the transistor is conducting at the time. So precautions common to any semiconductors are required.

I have just been advised by Fairchild that the prices on the epoxy micrologic used in the keyer have been greatly reduced, as follows: The 9923 flip-flop is now $1.50; the 9914 gate, $0.80 in 1-24 lots. This cuts the price of the IC's in the keyer by nearly two-thirds. This should be welcome news to those considering building the keyer.

And finally, I would be pleased to contact anyone using the Micro-Ultimatic on the air. 7060 kHz at 0100 GMT Wednesdays I'm usually on.

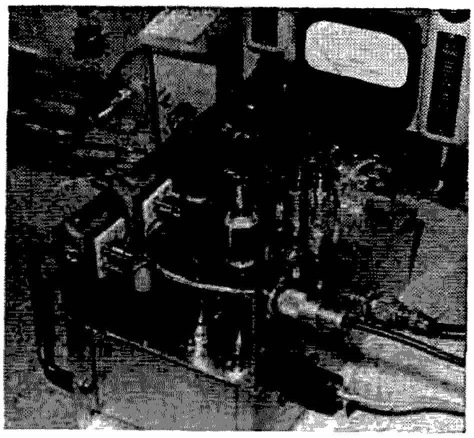
Tom Pickering, W1CFW
Portsmouth, R. I.

Dear 73:

The article by W1CFW in the June 73 on the Micro-Ultimatic Keyer is worse than any QST article ever published and as to reader interest, perhaps only one ham in the entire subscription list would be interested. Your articles are too uninterestingly technical. One can buy a good keyer cheaper than this complicated jobbie.

James Russell W8BU
Fairview Park, Ohio

Six Meter Transmitting Converter



Dear 73:

Thought I'd send along a photo of my 6 meter SSB transmitting converter which I constructed from your November issue. Designed by Joe Owings KØAHD. I found the rig worked excellently and no problems were encountered in construction or operating. Since March I have been assigned overseas and hold the call SVØWV and operate 20 meters mostly.

Keep the fine articles coming!

Dick Searle, K1VWJ/SVØWV

Government Support of Hams

Mr. Stewart H. MacKenzie
Huntington Bch., California
Dear Sir:

This refers to your letter dated June 12, 1966, which requested information concerning the next international telecommunication conference, its substance and potential impact on the frequency bands allocated to the Amateur Radio Service.

There has been a considerable amount of publicity during the past few years concerning the next international telecommunication conference and the possibility that amateur frequencies may be reallocated to other services. This publicity has been generated by and given extensive coverage in the national amateur radio magazines and periodicals and is an indirect result of the 1959 Geneva Telecommunication Conference which provided some frequencies in the 7 Mc/s amateur band for broadcasting in the African-European areas.

The amateur frequencies established for the American continents at the international conference held in Washington in 1927 have had only very minor modifications since that time. The United States proposals to the international radio conferences have always sought to maintain the allocation of the amateur bands, and it is expected that future proposals will endeavor to continue this status. However, with the creation of new countries, there is a continuing demand for more frequency space for the requirements of these new nations. The amateur frequencies are fertile ground in which to exploit their demands and it is highly improbable that such countries would be sympathetic to the amateur cause until their needs are met. It is this factor, among others, that has brought forth widespread fear in the radio amateur circles that the next international conference might reallocate segments of the amateur bands to other services. It is important to note, however, that a conference authorized to treat a subject such as this has not been scheduled and probably will not be for at least the next three or four years. If and when such a conference is called there is little likelihood that the United States will depart from its pro-amateur position. In any event, the public will be afforded an opportunity to comment on the position developed by the United States for that conference.

Ben F. Waple
Secretary
Federal Communications Commission
Washington, D.C. 20554

IMPORTANT NOTICE

We've had to revise our subscription list to satisfy the new Post Office regulations. Now all of our stencils are filed by Zip Codes. We can't find your address without your Zip Code, so please include it with all correspondence.

RSGB Handbooks

Dear 73:

About two weeks ago I received the RSGB Data Reference Book, and a day or two ago received the Amateur Radio Handbook. I still have to receive the RSGB Amateur Radio Circuits Book, which I assume is still out of stock? [yes] I am pleased with the British books and hope the other one is forthcoming soon. My best wishes for continued success of "73". You give the hams the meaty articles they want and not a lot of contest, etc.

H. F. Happoldt, K3YPV
Haverford, Pa.

Dear 73:

I have subscribed to the 73 magazine for the past couple of years and articles have appeared from time to time regarding the FCC, though to my knowledge there has been no mention of consideration to the old tried and true AM amateur stations still trying to enjoy the privilege of operating only to be washed by the unnecessary splatter of sideband operation killing the use of ten to fifteen kc of the band which could be used by perhaps four or five AM stations [not at once. Ed.].

What I am asking of you is if a poll of some kind could be gotten in favor of consideration to AM and submitted to FCC so there could be a bit of protection for the old and reliable type of transmission.

I would be very happy to help on any reasonable suggestion to help and preserve the use of AM to better advantage.

Thank you very kindly.

Claude Keneaster WA5LFL
El Paso, Texas

Gravitation Error

Dear 73:

Dwayne Hendricks WA8DZP, of Tek-Dayme Research, has sent me a letter about a typographical error in a letter to you published in the May issue of 73 about gravitation. The volume of the gravitation was given as 6.3×10^{-12} cm^3. It should be 6.3×10^{-42} cm^3. These values were obtained from Nuclear Dynamics by Dr. Nicholas J. Medvedeff, one of the leading physicists in the U.S.A.

Tom Appleby W3AX
President
Mahlon Loomis Scientific Foundation

The FET Voltmeter Is Great

Dear 73:

I am really surprised at the way 73 magazine has passed up the other two major ham magazines. I buy a ham magazine because I want to learn more about solid state circuits and 73 has more information about this than any other magazine. I have built the Field Effect Voltmeter (July, 1966 page 34) and Richard Palace, K3LCU, is right. I have put aside my high-class test equipment for this low-cost unit that makes others look sick. As you know, it doesn't run from 110 Vac so you can take it with you in the field. Keep up the fine work and articles on solid state circuits. Thanx for a good magazine.

Tom Adams, WA6KSS
Monrovia, Calif.

Ham Use of Semiconductors

Dear Paul:

I read with great interest (and fulminating concern) your comments in the July issue regarding the apparent inability of the "Handbook" to keep up with the current state of the art so far as semi-conductor technology is concerned. I have felt for quite a few years now that electronics is outrunning the "bible", but you are the first I have run across to state it in print. My congratulations.

The broadcast industry is one of the most conservative concerning adoption of new electronic techniques. After everybody else makes all the mistakes, broadcasting will step in and utilize equipment that has had all the bugs ironed out. Yet almost all new broadcast equipment bought or built today is 100% solid state. Transmitters are available for no more than 20% greater cost over tube models up to 5000 watts that are all transistor except for the final. The two primary reasons for retaining tubes in finals are cost and susceptability to lightning damage.

For a business that bases its entire operation on the successful, economical operation of reliable electronic equipment with a minimum of man-hours (these men have other things to do) spent on upkeep, indifference to the advance of the state of the art would be technical suicide.

I would feel the same thing might apply to ham radio. Have not we been famous as technical innovators? Hasn't it been our reputation as the hobbyists who "play" with electronic inventions to be the first to come forward with the practical systems? Maybe I'm an alarmist, but I feel that hams have been in the forefront of electronic engineering until just recently, but now we seem to be falling behind. I don't know a radio amateur worthy of being called one who can't tell you what happens inside a vacuum tube, but I know very few who can say what happens inside a transistor coherently. All that comes out is some foggy reference to the movement of "holes" or some bland statement that "they work just like tubes, except you reverse the B plus and lower the voltage." Concepts like these are what perpetuate the general feeling among hams that transistors are unreliable, but interesting little novelties. Nothing is farther from the truth. Used correctly they are the most reliable and interesting active electronic component available to us today. It is about time the hobby as a whole accepted this and got on the bandwagon. This means the Handbook needs to be bigger . . . lots bigger. Maybe this will cost more, but it would be worth it. Send the editors back to school if necessary. It seems a sad criticism that there were more technically valuable semi-conductor articles in the July issue of 73 than in the entire 1965 Handbook. 'Nuff said?

Steve Broomell WØPGN/7, Chief Engineer
KAII, Casper, Wyoming

Get Your Extra Class License

Dear 73:

My article on the extra class exam and programmed texts appeared in the July 1966 issue of 73. I have had tremendous response to this article, and I have received at least a letter per day since that issue came out. Boy, 73 articles really get the coverage!

Here's some additional information I've been giving to those hams who responded to my article. First of all, the sample programmed lessons of Fig. 2 in the article didn't come from any published text. I wrote these myself especially for the article. Maybe I should write a programmed book.

Second, since I wrote the article there have been several more programmed texts published. I've listed these below. There is a pretty wide selection available now and most hams shouldn't have too much trouble in finding one to suit them. Also, new programmed texts are coming out every month or so, so keep in touch with your local bookstore.

Recent Programmed Texts

"A Programmed Course in Basic Electronics", New York Institute of Technology Series, McGraw-Hill Book Company publisher.

"Electronic Troubleshooting", Philco Technical Institute, Prentice-Hall Inc., Publisher.

"Logical Electronic Troubleshooting", by Donald Schuster, McGraw-Hill Book Company, Publisher.

"Electron Tubes at Work", by J. B. Owens and Paul Sanborn, Tutor-Text, Doubleday.

"Fundamentals of Transistors (Programmed), RCA Service Company, Prentice-Hall Inc., Publisher.

"DC Circuit Principles",

"Simplified Transistor Theory", both by Training Systems Inc., and Stanley Levine, Hayden Book Company Inc., Publisher.

I am pleased that my article has been so helpful, and thanks to 73, it was published.

Louis E. Frenzel, Jr., W5TOM
Houston, Texas

AM on 20? Bah.

Dear 73:

There are a couple of items having to do with frequency allocation and usage in the 20-meter band which have been bothering me for quite some time. Although both subjects have been brought up in the past, I think the time is right for further discussion in a national magazine.

First, I feel that the frequencies between 14.150 and 14.200 MHz are a "vast wastland," i.e., they are receiving much less use than the rest of 20 meters. From my vantage point on the West Coast, it appears that the only use of this band segment is: 1. Some AM (and a few SSB) stations from VE-land; 2. An occasional DX station transmitting around 14.190 to 14.199; and 3. An occasional phone patch from KR6, etc. I maintain that all three of these uses are absolutely nonessential and this band segment would be put to much better use in this country if it were open to U.S. phone stations. If the FCC goes ahead with incentive licensing, perhaps part or all of this segment could be used by amateur extra licensees only; otherwise, why not open it to all holders of conditional class or higher?

The second subject concerns what I've been hearing lately between 14.200 and 14.250 MHz—that portion of the band set aside by "gentlemen's agreement" as the sole province of AM phone stations. Recently this band segment has been more and more populated with SSB stations; furthermore, many DX stations have been working U.S. SSB stations here. This is a logical development in view of the number of amateurs with transceivers who cannot send and receive on different frequencies.

I propose a new gentlemen's agreement: An agreement by AM stations to refrain from transmitting on 20 meters. This shouldn't be much of an inconvenience for anyone, since there seems to be less AM activity on this band as time goes by. Those who choose to work AM as a matter of personal preference can do so on other bands (with less interference from "side-winders"). Certainly there remains no argument on the relative merits of SSB versus AM for long haul work. Need I say more?

I hope that my ideas will be of interest to other active amateurs; I am sure that their implementation would be of great value to our important 20-meter phone band.

Gerry WA5FRL/WB6PHU
Pacific Grove, Cal.

An OT Looks at Code

Dear 73:

For 35 years I have felt that it was right and proper that every amateur should learn the code for a license. I went through it, why not everyone else? Recently I have changed my mind!

I have been helping a couple of Novices improve their code. One is 79 years old, the other a brilliant young engineer. Both of these fellows are in the last months of their Novice licenses, and, although they are on the verge of passing the code, neither can quite make the grade. The old gent will never be able to write 13 wpm with a pencil. His old fingers just won't go that fast. His Novice license is a means of something to do. He lives out in the desert by himself, and will now have to give up. The young engineer understands all there is to know about electronics and designs our defense systems. At home he copys 20 wpm but blows up at the radio inspectors office. Every month for five months he has plunked down $4.00 to take the test and missed by one letter. He never expects to use CW, in fact he hates it, but likes SSB and construction. The old gent is hard of hearing, CW comes through where SSB does not. There must be a moral.

Have we been wrong? Why can't the Novice stay on forever if he likes CW at 5 wpm? Who is he harming? How many Novices can pass 13 wpm at the end of the year? I have not found one with whom I have been in contact? How many phone men could pass the code if the RI came around?

The excuse for CW was to provide CW operators for the military. Do we still need CW operators when the infantry soldier has digital communication back packs?

Since our license method is so screwed up, why not leave the Novice alone for a few years until he CAN copy better and give him a decent chance.

What was wrong with the old test 30 years ago: 10 wpm (a reasonable speed) and some theory? Whose ego are we trying to please by the complexity? A few who want special privileges because the bands are so crowded. At one moment we holler for more amateurs and the next for Extra class licenses. With the few Extra class licenses issued, I doubt if they will make any impact on increasing our engineering ability to save the electronic industry. Engineers are made in colleges. We are hams. Why not leave us alone?

I say let's have one reasonable license and a continuous Novice if we must, but let's *do something* and get this mess straightened out. It's been hanging fire too many years.

Ed Marriner, W6BLZ
La Jolla, California

P.S. I have the Extra class amateur besides commercial first telegraph and phone licenses.

Green, No. Articles, Yes.

Dear Sirs:

I do not in the least agree with your Mr. Green; in fact I think he is a rabble rouser.

However I must admit that 73 is printing some very good articles. So please enter my subscription for one year and I'll enjoy the magazine and try to ignore Mr. Green.

Eugene Bulton W6FVE
Modesto, California

On Wayne Green

Dear 73:

So you wonder what sort of a guy he is? Is he a crabby basket, an angry old man or an impatient young man with ulcers or what?

I confess I waited at the Air Port in Nairobi with mixed feelings. I had had several Q.S.O.'s with him and found him quite pleasant but his editorials!!

He must, as a successful author and editor of many years, surely be at least fifty or sixty. I had a hearty respect for his views and his editorials but some of them were Vitriolic and his debunking was at times merciless.

He would of course wear a tired lined old face showing the strain, on the other hand he was looking forward to skin diving in our lagoons, it didn't quite match up.

First Larry and Jim arrived and then a pleasant looking young man of about forty came through the barrier with

a wide grin across his face. "Hello Robby, nice to meet you" I was holding up a C.Q. and a Q.S.T. magazine for him to identify me in the crowd. He took the joke very well and we had a good laugh. My qualms vaished—for good. He is most entertaining to talk to and is interested in everything on this little earth and beyond including an inquisitive mind on flying saucers! A vast fund of general knowledge, an open mind (most surprising of all) and has a youthful burning enthusiasm for some of his hobbies of the moment combined with the maturity of well balanced views and opinions.

You have to be wide awake when he embarks on red hot topics such as the possibilities of us losing more ham bands. He feels far too many of us don't realize how easily we could be voted off all the bands by fragmented Africa, each separate little country with a voting power the same as U.S.A. and U.K. In fact I'm quite worried about it now but its a comfort to hope that the Crusaders like Wayne will save some of it, somehow, I hope!

About his editorials, I feel he has an impish sense of humour behind it all and perhaps a curiosity to see what would happen or how people would react! So when he writes his outbursts he keeps his tongue in his cheek. That's my opinion only of course but one day of safari is like a month on a ship or years of acquaintance.

I had a shock coming when I turned him loose in the shack. His left hand got cold, in fact it froze solid, on the microphone and he couldn't let go until 2:30 a.m.

He made his stateside contact and got his home messages off and said "Mind if I give a few boys a 5Z4?" He then started working three a minute with occasional short QSO's with special pals. It might surprise you but Wayne is an accomplished operator he was finishing off my log book when I went to bed and next moring I found a neat pile of foolscap paper closelined with 48 contacts per page!!

I didn't count up the contacts but they were quite a few hundred and for stretches ran three to the minute. He controls the crowd well and is a cool operator. I asked him why he ticked off one lid and left another alone, in fact went out of his way for him. It turned out that by the call sign the guy was pretty new whereas the other one was an old prefix "who should know by now how to operate."

He had that impish grin on again and was obviously wondering how the guy would react. The guy reacted ok and Wayne soothed him with a kind word and settled down again to three a minute.

Ok, so what, I know a few other guys who can do that but they are not Editors! Wayne does all his hobbies well and goes flat out.

When on safari we drove up to a fine herd of Elephant and Wayne was filming away. Suddenly a second herd appeared behind us. We couldn't go backwards or forward as we were on a swamp path. The second herd wanted to join the first herd and we were in the way and awfully close to them. Wayne just said "the first group is the better" and went on filming them. He's cool, outwardly anyway!

I usually get fun telling visitors "try again with the lens cap off" and so on, but Wayne used his movie and three cameras and a Polaroid in quick succession without any fluffing. He keeps them as preset as possible, that is, ready to shoot which is a great help to me as I found I could take him right up to a beast—and in an incredibly short space of time he had the shots he wanted and said "ok" and we slipped off before the animal could decide what to do about it.

The Masai guide spoke in English but occasionally spoke in Swahili for my benefit and said "Bwana Hapana Mbia" which literally means "The man isn't bad" which is high praise from a Masai warrior. It means of course that Wayne performed well. If he hadn't the Masai would have sniffed, spat out of the window and clammed up!

I hope Wayne will tell you of his great travel saga—it will be interesting if he does I promise you.

So there it is, a delightful companion, an alarmingly high I.Q., very thoughtful, hardly drinks, good fun and game for anything.

I must get this letter off to "73" magazine and see if they'll print it quick before Wayne gets back!

By the way—he eats too much!

Robby Robson 5Z4ERR
Nairobi, Kenya
August 11, 1966

We started quizzing the Alitalia people carefully to find out why our flight had been cancelled and when. The story we got was that it had been cancelled at least a day eariler . . . well before we had even left Boston. Why was it cancelled? Well, they explained that due to the U.S. airline strike there was a lot of money to be made in transatlantic flights and that the plane had been put on that run since it would bring more profit. I don't know how IATA feels about this sort of thing, but I'll bet the FAA would raise hell with an American line that pulled this.

That night we had dinner in Athens, hotel and food courtesy Alitalia. This was nice, but we were losing over $100 a day on our safari. The next morning we did the Acropolis and snapped beaucoup pictures. We did OK in Athens, only losing three cartons of cigarettes to the taxi driver that took us to the Hotel room (Hotel Elektra). It could have been much worse.

The flight to Nairobi left about 1 am the next morning (Friday) and stopped for an hour at Cairo at 3 am. Postcards were 25¢ each so we looked but did not buy. Next Asmara in Ethiopia for another stop. Then on to Addis Ababa where we stopped for an hour and a half while Africans crawled all over the plane

cleaning it. It was an Ethiopian Airline plane, so this was reasonable. Every flight was jammed solid and there was no possibility of sleeping in the crowded tourist section. We were rubbing elbows with men in white sheets, colorfully robed Africans and a good many Indians.

We set down in Nairobi at noon and, the customs formalities done, found Robby waiting for us. He identified himself by holding up a copy of QST and CQ. Bless him. Shamsu Din, the fellow who booked our safari, was also waiting for us. We drove about four miles into town and had a short lunch under the big thorn tree in front of the New Stanley Hotel. At the next table, I saw with dismay, was a long haired boy in tight dungarees and a black leather jacket. Good grief! He was with a group of boys and girls that could have been transplanted from Peterborough, New York or Stockholm.

The afternoon was taken with getting our hunting licenses, selecting our guns and registering them. Groggy almost to the point of incoherency we sacked out at Robby's house for the night. The next morning (Saturday) we admired his formidable barrage of antennas and nice station. I wish we'd had time to get on the air for a little bit, but we had to get downtown for a little shopping before driving to Nanyuki some 125 miles north for our safari. We bought safari shoes, safari jackets and safari hats and walked with just a touch of swagger down the main street of Nairobi. After stocking up on film we piled into Shamsu's car and were on our way. The car had a king pin about to give away plus two front wheel bearings burnt out so we didn't make very good time. We skipped lunch and drove straight through, stopping only for a half hour in Thika to have one of the wheel bearings replaced. We arrived in Nanyuki at about four in the afternoon.

Nanyuki is a very small town right next to the highest mountain in Kenya, Mount Kenya (17,000 feet). Nanyuki is right exactly on the equator, but because it is about 6000 feet elevation on a very large plain, it is relatively cool. There is a main street about two blocks long with a dozen or so stores run by Indians (called Asians) and off a block away one row of stores run by Africans. One that sticks in mind was the Butchery and Tea Room, an interesting combination. Shamsu suggested that we shop in the Indian shops as we might get into trouble in the other part of town. Hmmm.

The Sportsman's Arms Hotel turned out to be a pleasant place . . . rather run down by American standards. Old battered furniture, everything in need of paint, etc. The hotel is

Wayne on termite hill.

made up of 30 or so rooms in a motel arrangement . . . some all in a line, some separate cabins. My room had two single sized beds, a clothes closet and an old dresser. There were two beat up chairs. The bathroom had an old tub and a washstand. In a small separate cubical was the toilet. The lighting was from a hanging overhead bulb. Meals turned out to be large with six to seven courses, though the preparation was not inspired.

Relatively few of the Africans speak much English and you start right out getting a basic vocabulary of Swahili. You can get along pretty well with as little as fifty words and with 500 you are fluent.

Soon after we had had some sandwiches to make up for our missed lunch Fred Seed, our White Hunter, arrived. We set out immediately to zero our rifles and get used to them. We drove about two miles out of town to a rifle range and proceeded to see what we could do with a 100 yard target. One rifle turned out to be defective and it was nearly impossible to extract the used shell. The other worked OK, but was way out of adjustment and it took about 14 rounds to get it on target. Those shells cost over 50¢ each so we fired sparingly. Oh well, only one of us can shoot at one time anyway . . . and only Larry and I will be doing the hunting. Jim decided to devote his time to filming.

On Sunday morning we all drove out to the range again to make sure we had the .338 on target . . . seemed OK. Then we were off on the hunt. I was up first so I sat by the door of the Land Rover with Larry in the middle and Fred driving on the right hand side. In the back seat were our two gun bearers, watching out the sides for game, and Jim in the middle, popping up through the hatch in the roof to take pictures. In the very back of the car was the skinner, just in case we managed not to miss something.

The countryside was grassy . . . sort of a crab-grass stuff . . . with acacia (aa-case-eeya) thorn trees everywhere). These spindly trees grow about ten feet apart, are covered with extremely sharp thorns and are swarming with ants. The ants bite into the bark, causing it to swell up into blisters an inch or so in diameter, where the ants live. These are called whistling thorns because the wind blowing by these millions of blisters makes them whistle and you hear this eerie whistling sound when the wind blows.

We drove a couple more miles and were definitely in the bush. We began to see signs of animal life with little herds of Thomson's Gazelles running around. Fred pulled to a stop and pointed out a large Tommy ram and said to go after it. Kerede, my bearer, handed me the gun and I tried to load it. The shell refused to go into the chamber. I poked the shells in the magazine to get them to pop up and threw the bolt again only to have two shells try to jam in. I took them out and feverishly put them back in the magazine and tried to load again. No good. After about a minute of this ridiculousness I finally got a shell in the gun and the gun on safe. By then the Tommys were off in the woods out of sight. Kerede took the gun and we started off. I walked as carefully as I could, trying not to make any noise. Kerede crouched along, with me bent over trying to keep up with him, breathing harder and harder at the unusual position and suffering a bit from the thin air at this altitude. It was hot and sunny, about 75°.

We tracked them for about ten minutes and then Kerede motioned that they were spooked and we returned to the car. We drove for another mile and spotted another group of Tommys and we were off again. Same result.

Then, as we came out onto an open field I saw a lone Tommy ram grazing. I looked through my binoculars and he looked like a good trophy. Nearby I spotted a small grey dog sneaking up on the Tommy . . . it was a jackal. I jumped out of the car, took the gun and got in the clear and aimed as carefully as I could. A Tommy is about three feet high and not a large target. This one was a tiny tan spot in my scope wavering back and forth across the cross-hairs. I squeezed the trigger and watched for the puff of dirt and running Tommy. Instead the Tommy did a little flip and dropped. I was astounded. I reloaded in case he jumped up again wounded and ran across the field to him. He was about 200 yards away and I was well winded when I arrived. The shot had caught him in the back and killed him almost instantly. Not bad for

that distance.

It seems a shame to kill these beautiful little antelopes, but they are a pest to the farmers and cattlemen of the area and they want them killed. The whole area around Nanyuki is made up of large ranches and farms. Cattle raising is the big business here and most of the country is divided up into blocks of about 1000 acres which are fenced off to keep the cattle from straying. The antelope eat the grass, which is not all too plentiful. They've had little rain in the last two years and it takes about 50 acres to feed one steer.

One of the ranches (15,000 acres) recently sold for $90,000, to give you an idea of land values. The rancher must continue to improve his land or else the government steps in and takes it away from him, paying him their appraisal, and divides it up among Africans. The ranches still have a good deal of wild game on them and it is mostly a headache. Giraffes and zebras break the fences . . . antelope eat the grass, etc. The owner can go out and exterminate the game, but he must turn the carcasses over to the wild life department. He cannot use the meat or skins or sell any part of it. He gets a little help from hunters, but they are limited in the number of animals they can shoot by their licenses. My license permits me to shoot and eland and an oryx. I could have two impala, two waterbuck, three zebra, and a few other things. I bought a special license to shoot an eland and an oryx. I could have bought a license for elephant, rhino, etc., but I would have had to rent a larger gun and pay stiff license fees for this. Perhaps some other trip.

Larry was now in the shooting seat. Before long we saw a small herd of Tommys and he and his bearer Labun went out after a ram. We heard the shot after a few minutes and drove over and picked up the dead Tommy. A nice one . . . meat on the table for us and a nice skin for Larry.

My turn. We caught a glimpse of some impala. Kerede and I went after them. Kerede stopped and pointed . . . I aimed the gun and looked through the gun scope. All I could see was the rear end of an impala . . . I couldn't even tell if it was a buck. I went back to the car and got my binoculars and took a closer look. It looked like a lousy shot. Larry said he'd like to try it and he took a shot. Nothing.

We lunched in the shade of a larger thorn tree, washing chicken sandwiches down with warm Pepsi . . . tasted good at the time. A whole pineapple for dessert. OK, back to the hunting.

After a little driving around we came across

the impala herd again and I stalked them for a bit and saw that I wasn't going to get much closer so I steadied down as best I could and pinged. Miss. Damn.

It was late afternoon before we had another chance. I glimpsed a Grants gazelle off in the woods and Larry went after him. He blasted and the Grant took off. I could see he was hit and in trouble with my glasses. Larry and Labun went after him and Freddy, Kerede and I followed at a distance. We lost them. After about a mile we heard a shot and headed in that direction. Larry had finished him off . . . a very good specimen. Freddy went back and drove the car in to pick up us and the Grant.

It was quite a day. We had dinner at the hotel at 7:30 and went right to bed dead tired.

The next morning, our second day of hunting, I started the day off right by missing an impala buck. Larry got a chance at one a little later and again had to follow to finish him off. Bad luck. It was a fine old buck though with a nice rack. We went back to the hotel for lunch this time, being just about five miles out of town. We set out again at 4:30, when the heat of the day had cooled a bit and the animals would be on the move again. We were looking for impala so naturally everywhere we went we found Tommys. Late in the afternoon we saw some impala about 300 yards away. I got out and got up to about 250 yards when I spotted a tremendous buck. He was magnificent. I could see that he was about to spook so I steadied my gun on a fence post and took careful aim . . . just as I went to shoot he turned and left. Labun and I went after him for about a mile and I never had much of a shot at him. Finally, I popped one off in desperation at over 200 yards, but it was an obvious miss.

We drove into another ranch and some more impala turned up. Larry went with Labun after them and soon we heard a shot. I grabbed my telephoto camera and followed. I came upon them about 100 yards in the woods and Freddy gave me the gun and pointed to the impala herd still standing about 200 yards away. Labun went with me and soon I took aim at the buck he pointed out. He went down immediately and we found that my shot had hit him right in the heart. He was about 100 yards away. He didn't have as nice a rack as the one Larry shot so I decided to keep his skin, which was gorgeous. We also took the meat back to have for dinner. It was delicious.

The next morning I tried again for that big impala and failed to get near enough. Later on we were driving through some rather open woods when a nice group of impala spooked. Kerede and I followed them and as we were

closing in there on my left was a huge animal. I didn't have any idea what it was. At first I thought it was a Brahma bull, but the horns were wrong . . . and Kerede was telling me to shoot it. I aimed carefully and plonked him in the shoulder. He keeled over immediately, to my amazement. It wasn't until after the picture taking and excitement were over that I learned that I had polished off a near record waterbuck. He was too big to load in the car so they chopped him in half.

This was such a big trophy that it put a damper on the shooting and we spent the rest of the day sightseeing and taking pictures. We saw lots of ostriches, pelicans, secretary birds, and even giraffes.

The next day we drove out in a different direction and drove about 150 miles sightseeing. The country was fabulous and we saw baboons, lots of Tommys, Grants, impala, dik dik and even a small herd of eland. I was still off shooting so we just looked and clicked. We met a rancher there, a wonderfully interesting man, married to an African wife. He was just coming back from checking his herd of sheep. He has to sleep with the herd every night to keep Africans from stealing them. I wondered why he didn't hire a herder (government standard wage for herders is $20 a month plus food), but found that herders are OK for protecting the sheep against normal problems, but when rustlers show up they frequently strike a bargain with them and off go a bunch of sheep. So Jack sleeps with his sheep.

So far we had been hunting entirely on private lands. You have to reserve public lands considerably ahead of time if you want to hunt them and, despite his promises to do so, Shamsu hadn't reserved any hunting blocks for us. Fortunately Freddy had a good friend hunting in nearby Block 67 and he got permission for us to go in there and pop a zebra or oryx. Thursday morning we started out for 67. It was about a 40-mile drive to the check-in gate . . . then a few more miles to a little village of Ndorodor where we stopped and bought some candy and cigarettes to trade for photographs of natives. A local entrepreneur who called himself Lamumba took charge and got several of the local girls lined up for photographs, standing benignly behind them with his fly whisk. He could speak enough English to get by and we shelled out a shilling (14¢) each to the girls and a Polaroid photo for him. He wanted a dollar too, but we shoved off.

We were in Masai country now and every now and then we would pass one with a spear in hand, paint on his face, and interesting things hanging from his stretched earlobes.

One had a Kodak 35mm film can and was very proud of it.

Then we came to the escarpment. Here the plains at 6000 feet dropped off suddenly to about 3000 feet. The road wound itself down the face and it got hotter and hotter. This was more like the equator. We got to the bottom and found ourselves in very warm desert country. There were some fellows working on the road with Caterpillar tractors. One of them thumbed a ride with us about a mile from the bottom of the escarpment to a thorn enclosed camp about a mile away where police were staying. It seems there is a small war going on in northern Kenya. The Shifta, a nomadic tribe of about 250,000 living on the border of Somalia, didn't mind being ruled by the British, but object strenuously to being ruled by the Kenya government. The result is that they have been fighting a guerrilla war for the last two years. Apparently the communists have been supporting them and the fight has expanded well down into the northern frontier of Kenya.

We drove through the desert, seeing little animal life. There were huge mounds of elephant droppings, but at this time of day they were off in the surrounding hills to keep cool. A herd of oryx spooked as we came around a corner. I went off after them with Kerede and Freddy, but after fifteen minutes we saw it would be a long track and turned back. We had a nice lunch on the bank of the Kipsing river. The river was about ten inches wide with a dry-wash of about 50 feet or so. There were footprints from elephant, rhino and just about everything else imaginable.

It was getting late in the afternoon so we headed back. The trip up the escarpment was a dilly. The Land Rover had to go in its lowest gear with all four wheels engaged to make it in many places. Little else could possibly get up there. As we went through Ndorodor again Lamumba flagged us down and asked us to take him and his wife to Nanyuki. No. But his child is sick and must get to the hospital. OK, we'll take them to the hospital, but no place else. So he loaded his wife and two children in the back of the car and jammed himself in the back seat beside Jim, whisking him a few times with his fly whisk. He smelled pretty boozy, among other things. When we arrived in Nanyuki he lost his command of English and Swahili and could understand nothing we said. He did communicate that he wanted to get off at the Butcher and Tea Room, the local drinking place. We obliged and Freddy again vowed never to give another ride to anyone, no matter what.

We learned the next morning that the Shifta

had struck at the foot of the escarpment, right where we had been, about an hour after our passing and six men were killed and three wounded. That was a close call.

By Friday our bloodthirst was back and we set out for more hunting. I started the day out right by walloping a nice impala. It was a very good shot and, when we took him apart, found that the bullet had exploded his heart. Even so he made it about fifty yards before dropping and I was afraid I had just wounded him. The shot was about 100 yards. I have to admit that I muffed an impala earlier though. I thought I was dead on him and the bullet whacked as if it was a hit. The impala just stood there so I was sure it was a hit and he would fall down or else I would have shot him again immediately. Then he wandered off and I pinged another after him, missing again. There was a nice hole in the tree just behind him, the whack we heard. You can usually tell, even from quite far off, if a shot is a hit.

Baron Von Scheken, one of the most progressive farmers and ranchers in this area, was most anxious to have us bop some of the zebra that are breaking his fences so he drove out with us in his Rover to show us where the herd was at the moment. Larry and Labun took off on a long stalk with Freddy backing him up in case of a wounded animal. They must have been gone almost two hours before the shot came. No whack, so it was a miss. They came back to the car and we headed off to try to find them again. Suddenly we came on a herd of waterbuck. It was my turn to shoot, but I had my waterbuck so Larry got out again and went with Labun into the woods to circle them and come in downwind. We drove off to allay suspicion. About twenty minutes later came the bang and whack. Good. We drove back but couldn't find either of them. About fifteen minutes later they came in view. It seems that Labun had followed the wrong waterbuck and the one Larry hit was just about 50 yards from where he had killed it, behind a bush. We took pictures in the failing light. It was a fine waterbuck. The Baron was pleased.

On Saturday (today) Larry went out alone while I stayed at the hotel pecking out this brief report. He came back about ten in the morning to announce that he had knocked over two of his three zebras already. I sure hope that I'll get one or two tomorrow when I get out there.

The hunting is enjoyable . . . the weather here is excellent. We need every one of those four blankets at night even though we are on the equator. We'll hunt another week here and then pop on back to Nairobi for a few days, probably visiting the game preserve there

with Robby and then driving down to see the Lake Amboselli game preserve. From there we plan to visit Murchison Falls in Uganda, with a stop at 5Z4JW on the way. Then, if things are calm in the Congo, we will drive over and visit 9Q5HF and 9Q5IA and back into Rwanda to 9X5GG. If things are touchy there we may come back earlier and go on our way to ET, ST, SU, OD, etc.

The time was when a hunting safari to Kenya was a very expensive deal, possible only to the very wealthy. It entailed dozens of men to carry the tents, food, guns, and equipment and weeks in the jungles fighting off heat, bugs, and dysentery. I'll tell you exactly what this whole works cost when I get all done, but right now the basic expenses have been $690 for the three weeks in the hotel plus all hunting costs, though we cut down on this a bit by splitting the total cost for two hunters and one non-hunter ($345), coming out to about $575 each for the three weeks. The gun cost $90, including the license and 140 rounds of ammunition. The hunting license cost me $120, though I could have just as well bought the $57 license if I hadn't included the right to shoot on public lands and the special orxy and eland permits. I figured that since I don't get to Africa all that often I had better spend the extra and be sure. Larry bought the private land $57 license and has had no problem. They even have cheaper license available if you want to just shoot one each of the plains game . . . and for only $14 you can go out and pop two animals. Something for every pocketbook.

I'll have some expense in getting my trophies prepared and skins tanned and shipped back to the U.S. And add $100 or so for films . . . better make that $200 since I shoot first and ask questions later. And we'll have to budget perhaps $50 each at most for tips for our gun bearers. The whole works is still a fantastic bargain. Of course the fly in the ointment is the air fare over here, which is brutal. It is almost the same as the around-the-world fare . . . it cost me about $200 extra to continue from Kenya on around the world rather than just flying straight back.

I was surprised to find out how few people come to Africa to hunt. I don't know what I imagined, but last year they sold only 480 hunting licenses and this year they hope to break 500. When you consider that the great bulk of the hunting in Africa is taking place in Kenya you can see that few people are involved yet. For that matter there are only 62 fully licensed professional hunters and only about 20 of those make a full time job out of the profession. Eight of the hunters live in

Nanyuki, so you can see that this is a very popular game area.

Kenya has been self-governed for just two years so far and it is really going quite well considering the enormity of the problems they faced. The total population of Kenya is a little over 10 million of which about one half million are Asian and 50,000 European (white). Few of the Africans have had much education and you might draw a rough parallel if you imagined what would happen to our country if suddenly it were turned over to seven or eight year olds to run. The Africans are just two or three generations from complete tribal savagery and old patterns of living take a while to change. The change has been tremendous already, but there is a long way to go.

I find just about everyone here optimistic about the future of Kenya. Freddy wants to start an animal farm similar to some very successful ones down in Rhodesia and run a sort of dude ranch affair with horses and camels, camping expeditions and plains game hunting for those interested right on his ranch to keep the animals under control. It's a new approach and I'll bet it would work. If the supersonic planes bring down air fares Kenya will be crowded with tourists.

Listen for me on 14230. I'll be on there at every opportunity, wherever I am.

. . . W2NSD/1/5Z4

James Ashe W2DXH
R.D. 1
Freeville, N.Y.

Zener Diodes

This excellent article explains how zeners work, how to use them, how to test them, and how to buy them. It's another of 73's technical feature articles.

One of the many solid-state devices now available to the radio amateur builder is the zener diode. Properly used, it serves as a reference voltage source capable of delivering considerable current. Unlike a battery, its life is indefinitely long, although it must be supplied with a continuous current for many of its applications. This article contains the basic information required to intelligently design and use zener diodes, and some selected sources of information from the rather sparse supply are listed in a bibliography at the end.

For instance

The number one application of zener diodes is probably dc voltage regulation for transistor circuits. Suppose you have just purchased a new 1N2974 zener for about $5.10. The catalog says 10 watts, 10 volts, 20% tolerance. Since you lack experience with zeners, you breadboard the intended circuit to pick up a few details on what zener regulators do. Perhaps the circuit is that of Fig. 1. Careful! The illustrated circuit is more suited to my purposes than yours! You turn it on and this might be what happens:

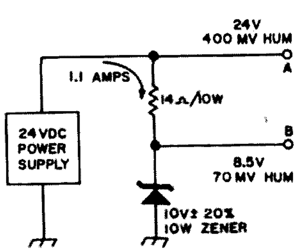


Fig. 1. A possible hit-or-miss zener regulator circuit. What's wrong with it?

A voltage measurement reveals regulation at 8.5 volts rather than the indicated 10 volts. You notice the voltage seems to be creeping up as you watch the meter. A signal tracer probe on point A finds lots of hum; but there is some at B too. Perhaps if some current is drawn from B the hum will decrease. A load test shows little effect on the hum except that under very heavy load the hum increases . . . some other noise too! Thinking about that, you smell smoke; it's the series resistor overheating. As you reach over to turn off the power supply, you notice the zener voltage seems to have dropped to zero. This reminds you that the zener has been operating without a heat sink. It's failed completely! Terrible. You can avoid the damage to wallet and peace of mind by using the following material. After reading, get out a pencil and some old envelopes or something, and design zener circuits. You'll soon catch the idea!

Zener facts

Zener diodes are supplied in a large variety of packages. The controlling factor is how much heat must be dissipated. A majority of the zeners available are supplied in a diode-like glass package for up to 250 milliwatts, a wire-mounted cylinder resembling a resistor or a silicon rectifier for the 1-watt size, a stud-mounting package for the 10-watt size, and a

larger package resembling a power transistor for the 50-watt size.

A catalog search brought out hundreds of zeners rated from 250 milliwatts to 50 watts. Some engineering books mention zeners as small as 50 milliwatts (Cutler) to as large as 100 watts (Littauer). Operating voltages ranged from 3 volts to 200 or so. The least expensive were priced at 75 cents (General Electric Z4XL series). $20 seemed to be the upper limit, with a large variety in the $4-$7 range. Price tends to increase with higher power rating and closer tolerance, but some good zeners are available in epoxy packages at low prices.

Some ordinary silicon diodes and transistors may be used as zeners.[1] General Electric says some of their epoxy cased transistors can be used in this way. But most zeners are slightly special silicon diodes, designed to dissipate the fairly large amounts of heat produced in normal zener operation. Small zeners dissipate the heat along their leads or into the air; 10 watt

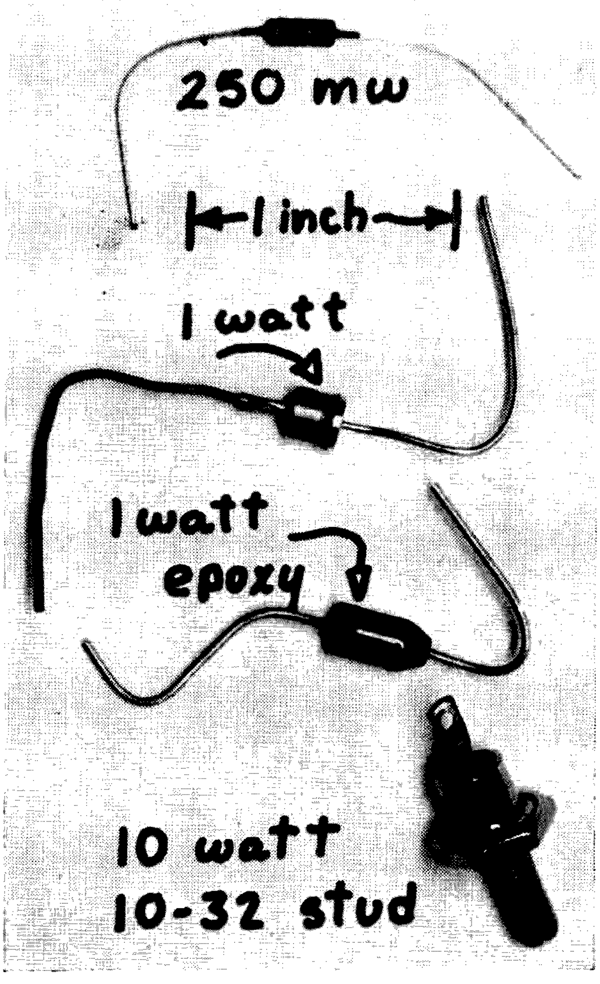


Fig. 2. Some typical zener diodes. They look just like ordinary diodes. Perhaps some of your diodes are zener diodes!

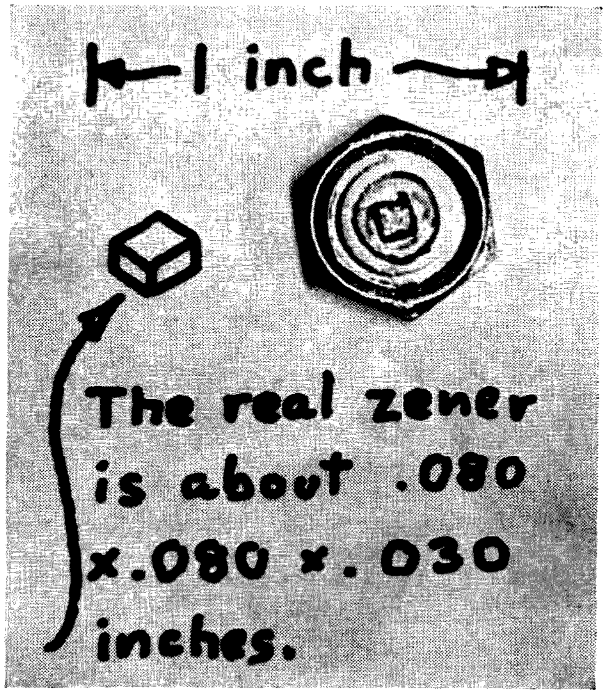


Fig. 3. Inside the case of a 10-watt zener. The actual PN junction is in the tiny square at the center of the circle.

and larger zeners are built like power transistors. The semiconductor material is brazed to a copper stud or surface which provides the route for dissipating excess heat into the required heat sink. **Fig. 2** shows some typical zeners.

Only a small part of the package called a zener diode is actually the working element. This key piece is a semiconductor PN junction formed on a silicon wafer by a process involving some heat and considerable accuracy. **Fig. 3** shows the interior of a 10 watt zener. In normal zener operation the PN junction is biased opposite to the direction of easy conduction, at a voltage great enough so it conducts anyway. Sounds rough, but works fine. The arrangement is called reverse bias, and the zener always appears in the schematic with its arrow pointing toward the positive supply line. **Fig. 4** is a graph of current plotted against voltage for normal zener operation.

A small voltage invokes very little current. As the voltages approaches 10 volts, the current increases quite drastically toward some terrific value as the zener begins to act like a short circuit. If there is no current-limiting resistance in the circuit, the zener will promptly perish. This very rapid current upon voltage dependence gives the zener its useful voltage regulating property. The region of the

[1]See K9VXL's article, "Save That Transistor!" in the July 73.

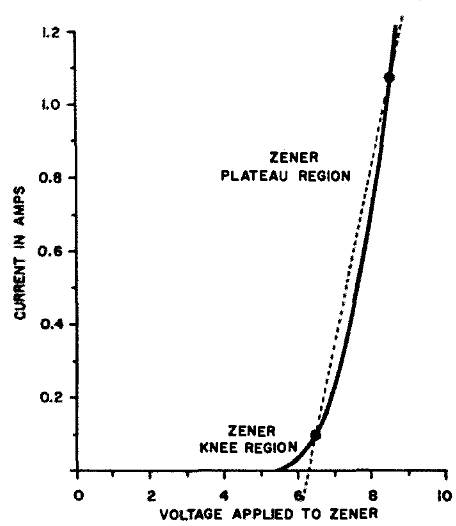


Fig. 4. How zener current depends on applied voltage for a 10 watt zener. The rise beyond the knee is so sharp the zener must be supplied from a current-limiting resistor or circuit.

curve in which the current first begins to rise is called the zener knee, and the normal operating region is called the zener plateau. The useful plateau is limited at one extreme by the current required to keep the zener action alive, and at the other by temperature increase sufficient to destroy the zener.

The zener regulating voltage depends on how thick the PN junction is. If the PN junction is very narrow, the zener will regulate at a low voltage; we leave these details to the manufacturer. But depending on the structure of the zener it may show an increase or a decrease of voltage as it gets warmer! Zeners under about 5 volts will show a decrease in voltage, over about 5 volts a rise, with increasing temperature. A happy choice of voltage and current will give a zero drift: 40 mA at 4.8 volts, to 3 mA at 6 volts. Review the manufacturer's specs if real stability is required. Two or more zeners in series will show a smaller temperature voltage drift than a single equivalent higher-voltage zener.

Type	Price	Nom. Voltage Test Current	Watts	Tolerance	Dynamic Resistance in Ohms
1N4728A	$1.93	3.3@76 mA	1	5%	10
1N4733A	1.93	5.1@49 mA	1	5%	7
1N4735A	1.93	6.2@41 mA	1	5%	2
1N4739A	1.93	9.1@28 mA	1	5%	5
1N4747A	1.93	20@12.5 mA	1	5%	22
1N4752A	1.93	33@7.5 mA	1	5%	4.5
1N957B	2.95	6.8@18.5 mA	0.5	5%	4.5
1N3016B	3.70	6.8@37 mA	1	5%	3.5
1N2970B	7.30	6.8@370 mA	10	5%	1.2
1N2804B	10.65	6.8@1.85 A	50	5%	0.2
Z4XL6.2	0.75	6.2@20 mA	1	20%	9
Z4XL6.2B	0.84	6.2@20 mA	1	10%	9

Fig. 5. Types, prices, and characteristics of some typical zeners. Note variations in dynamic resistance.

Zener specifications

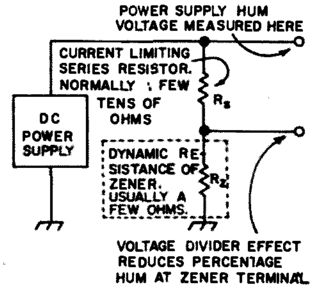
All zeners are supplied with a voltage rating, and a tolerance. Like resistors, the standard tolerances are 20%, 10%, and 5%. The nominal values are usually chosen in the same way as those for resistors, resulting in voltage ratings that should sound very familiar. The system is based on the twelfth root of ten for 10% zeners, so you will find for instance, 3.3, 3.9, 4.7, 5.6, etc., voltage ratings. **Fig. 5** lists some zeners and their properties. If you are trying to regulate to a critical voltage, a germanium or a silicon diode may be placed in series with the zener (small increment) or in series with the load (small decrement).

The temperature drift problem can be minimized by keeping the zener cool. This conflicts with power handling ability but tends to guarantee long life despite experimental accidents. Like all semiconductor materials, if a zener PN junction gets too hot, the doping atoms begin to jump into new sites. This is very bad for the zener! Since the junction may withstand temperatures as high as 200 degrees Centigrade, zeners are not remarkably fragile. But they cannot withstand the kind of overload even small power supplies can produce.

Zener wattage, as in any resistor, equals voltage across the zener times current through the zener. Check manufacturer's specs if much power is to be handled or if operating near maximum ratings. For breadboard and quick-and-dirty construction the fingertip test will do: too hot for a five-second fingertip touch equals too hot.

The zener's ability to stabilize and filter a power supply output is indicated by its dynamic resistance. Low dynamic resistance is desirable. Suppose you wish to have power supply output stay within one-tenth volt of nominal in spite of 100 mA variations in current. By Ohm's law that works out to one ohm: this is the dynamic resistance required. High wattage zeners, near 6 volts, have better dynamic resistance than any others; high voltage zeners have very poor dynamic resistance but are not required for most semiconductor

Fig. 6. Equivalent circuit for estimating how much a zener regulator will reduce the percentage and amplitude of power-supply hum.



circuits.

The practical effects of dynamic resistance can be brought out by drawing equivalent circuits to show what's involved. An equivalent circuit is something used by engineers to simplify circuit problems. The dotted box suggests "we imagine the actual device acts like what's in there." From a hum viewpoint, the zener improves the situation as if the entire circuit were a voltage divider. The upper resistor is the required series resistor R_s and the lower resistor is the zener's dynamic resistance. This is usually listed in the catalog entry. If the dynamic resistance is one ohm, and the series resistor is fifteen ohms, the usual way of working out voltage-divider circuits tells us the hum will be reduced by a factor of 16. That doesn't remove it! Typical hum from a capacitor filter low-voltage supply is a half volt to three volts. This would result in anticipated hum figures 30 to 200 mV; still plenty of hum.

Fig. 7 shows the way to estimate how much the zener voltage will change under load. This figure is very different from the actual circuit so do not feel stupid if it's not clear! Try this with an actual zener when you've finished the article. Measure the zener voltage at a current near the knee. Measure it again at near maximum zener current. It will be higher. Now write down that higher voltage next to the 'inside battery.' If you draw current from this equivalent circuit, the voltage will drop because of losses across the inside resistor. This is just what the real zener circuit did: the small zener current corresponds to maximum load condition from the equivalent circuit. The voltage change divided by the current change gives the value of the series resistor. It will be the dynamic resistance again. This shows that knowing the dynamic resistance is very useful in reckoning the effects on regulated voltage of changes in load current.

Zener noise

The useful ability of zeners to control circuit hum and noise is somewhat compromised by their natural ability to generate signals of their own. The zener regulating process is like an electrical discharge, and can produce similar noise. Good zeners produce very little noise, but some may become quite loud in the zener knee region. If your new circuit seems to be troubled by erratic frying and hissing noises, and this is traced to the zener regulator; the two solutions are increasing zener current to keep it out of the knee region, or the addition of a capacitor to take up the noise. Try 0.1 μF to start.

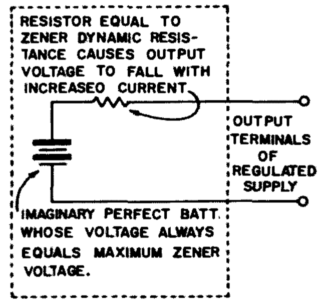


Fig. 7. Equivalent circuit for reckoning voltage drop with increased loading of a zener regulated supply.

Varactors are reverse-biased silicon diodes. Since zeners are also reverse-biased silicon diodes, do they have an associated capacitance? They certainly do; it may be as large at .01 μF. This capacitance is unimportant in normal operation, and probably has a beneficial effect in reducing zener impedance at high frequencies. Perhaps this capacitance can be put to other uses! Might be an easy way to double up to 40 from 80 meters. Another possible application would be oscillator tuning; perhaps a cheap zener would work better than a cheap silicon diode. All this brings to mind Fisk's interesting article in the March 1966 issue of 73.

Zener regulator design

All zener circuit designs depend on the same basic facts of the zener's voltage, tolerance, wattage rating, dynamic impedance, and perhaps temperature drift. The worst case from the zener's viewpoint is DC power regulation, with a steady current supply from a voltage source capable of destroying the zener if the series resistor fails or is shorted. Zener regulators are very useful and deserve a close examination.

Only professional engineers should design zener circuits to operate at the limits of the zener's capabilities. The amateur, by leaving generous margin for error, can simplify the design problem to a point where only the simplest math and less than complete information on the zener's capabilities will be sufficient for a reliable design. Apart from possibly very serious misunderstandings on the amateur's part, the major troubles that might arise are the relatively generous tolerances on most inexpensive zeners, the wattage problem, and voltage change under load resulting from dynamic resistance.

The design process commences with finding some working figures. Refer to **Fig. 8**, a design sketch made just before carrying out the following procedure. Power supply voltage, zener voltage, and load current information are collected, along with their estimated maximum and minimum values. A class B audio ampli-

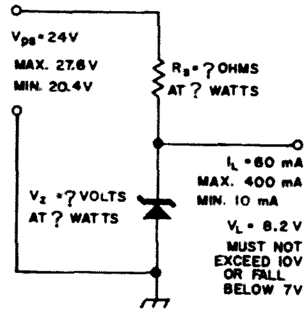


Fig. 8. Designing a reliable zener regulator. The question marks indicate values to be worked out.

fier of a few watts capability could account for the fairly large current variations shown in the diagram; this is a rather extreme case. But it could happen! If the load were a receiver small-signal circuit, an oscillator, or a transmitter VFO; the load would be practically constant. After collecting this information from figures, estimates, educated guesses, and by breadboarding, the circuit is designed on average values. When a series resistor and a zener are chosen, their anticipated properties are checked against possible extreme conditions of voltage and amperage.

Variations in load current are made up by opposite variations in zener current. Minimum zener current flows when maximum load current is taken from the regulator. This adds up to the first requirement for the zener: it must carry a current greater than the anticipated load swing. The regulation fails if the zener is starved into the knee region, and if the zener is overheated by excessive current, catastrophe is likely. Often a well-placed large capacitor in the load circuit will absorb the drastic swings. The zener required in **Fig. 8** must carry more than the swing of 390 mA. If the minimum and maximum loads were both greater by 1 A, the swing would remain the same and so the zener minimum current requirements would be unchanged. However, with increasing loads flowing past the zener, a point may come at which turn-on or turn-off of the circuit results in transient overloading of the zener.

A safe minimum zener current is 10% of its maximum rating. A fresh zener accompanied by manufacturer's specs may be used at much lower levels, taking the specs as a reliable guide. For surplus zeners the 10% lower limit is recommended unless a test shows the particular zener will stand further starvation. Since the voltage requirements are already determined, the choice is made on the basis of wattage. Don't be afraid to use an oversize zener; it's safer and the larger zener will have a lower dynamic resistance. The absolute minimum wattage required equals the maximum possible voltage across the zener times the maximum expected current through it. There seem to be no 5 watt zeners; for most regulator purposes the choice is limited to 1 or 10 watts. Or 50 watts if you wallet can stand the drain. The zener in **Fig. 8** should carry about 450 mA under minimum-load conditions; at 9 volts that works out to just under 4.5 watts. A 10-watt zener is indicated.

Now the series resistor R_s can be chosen. The voltage at its upper end is fixed by the power supply, and at its lower end by the zener. The series current is the maximum load current plus the minimum zener current finally decided on . . . in the case of **Fig. 8** this was a total of 450 mA. This same current flows if the load drops to 10 mA, since the zener now takes 440 mA. Knowing the voltage across the resistor, 24 volts minus 8.2 volts, or 15.8 volts, it appears that a resistance of 35 ohms and about 7 watts is the minimum value.

This leaves no margin for error. A better choice is an Ohmite adjustable wire-wound resistor, 50 ohms, 25 watts. More than half the resistor will be in the circuit. If only half or 25 ohms were used, it would still be rated at 12.5 watts, so that with this choice the success of the design seems probable.

Now we return to the zener. Any electrical slop in the design can be taken up by the resistor, and we know that a 10-watt zener is required. Referring to the catalog, we find a 1N2973B, 9.1 volt 5% zener. We expect the circuit can withstand the possibly slightly high voltage. If not, we'll change the circuit. We choose a zener at the high end of the range because its voltage will drop under load: a dynamic resistance of 2 ohms means 2 volts drop per amp decrease in zener current, or in the case of **Fig. 8** the voltage will swing over a range of 0.23 volts. Adding to this the .45 volts possible error due to zener tolerance, and adding that to the 9.1 nominal zener rating gives about 9.8 volts as the largest we should expect to see in the circuit. Subtracting the same figure from the 9.1 nominal figure gives a minimum of 8.4 volts in the case of an extremely low valued zener. These results are within the previously decided requirements.

There is still the question of changes in power supply voltage. What happens if line voltage changes drastically? This cannot be answered simply; some line voltages are more changeable than others! In **Fig. 8** a 10% variation either way was just picked out of the air. This is probably large. Now if the zener voltage is fixed at 10 volts, which it will never quite reach in the actual circuit, and if the supply voltage drops to 20.4 volts; the series resistor being at 35 ohms with 10.4 volts

across it now passes only 335 mA. Not enough, so we adjust the resistor to 23 ohms, and it now passes 450 mA. But now we must try the other extreme: the power supply voltage rises to 27.6 volts and we suppose the zener to be an 8.4 volt type. Then we find 19.2 volts across a 23 ohm resistor. That is about 840 mA. The zener won't overheat if it is properly mounted, but the resistor must dissipate 16 watts. Since less than half of it is carrying current, we must go to a smaller resistance at the same wattage in order to get enough dissipating surface. The choice is a 25 ohm 25 watt resistor, still adjustable. Or if you're a little apprehensive about going that close to the limit, a 50 ohm 50 watt resistor can be purchased at an 83 cent increase in price.

That completes the design. This process avoids the following kinds of grief: Zener failure due to overheating; zener voltage out of specs; circuit loads zener regulator into the knee region; regulator fails due to starvation or overheating at extreme line voltage values.

Correcting zener voltage

The combined effects of high prices and large tolerances are hard to beat! But a resourceful amateur need not lose a project just because his nearest zener isn't quite near enough. Zener voltage can be adjusted up or down by correct use of small germanium or silicon diodes. The price is a slight increase in dynamic resistance and in temperature drift. Some knowledge of the properties of forward-biased diodes is required.

A silicon or germanium junction diode, carrying a forward current of 10 to 100 mA, depending on its size, has properties very like those of a low-voltage zener. In fact, there are no zeners under about three volts, and diodes are used in just this way to fill the remaining gap down to near zero. Beyond the early stages of conduction, a few microamps or mils, the diode voltage changes very little with current. Its dynamic resistance is quite low. Diodes can be used in zener circuits as if they are little batteries, to achieve a slight increase or decrease in apparent zener voltage. The voltage measured across the zener itself is not affected.

The voltage at which the diode regulates depends on its material: germanium or silicon. A germanium diode well into conduction will show a stable voltage of around 0.3 volts; a silicon diode regulates above 0.7 volts. A transistor base-emitter or base-collector junction could be used in place of the real diode; it's a PN junction too and will show the same behavior.

To achieve a small increase, the diode is

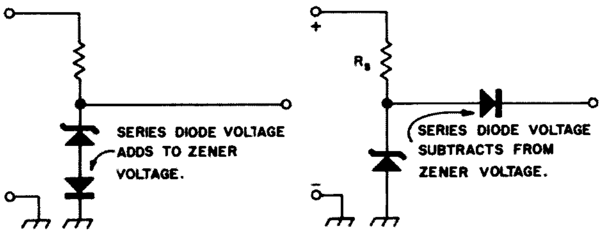


Fig. 9. The effective regulating voltage can be adjusted by correct application of ordinary germanium or silicon diodes.

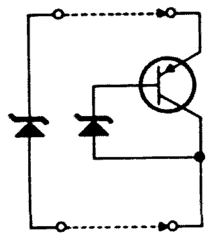
placed in series with the zener, as shown in **Fig. 9A.** The reverse-biased zener and the forward-biased diode point in opposite directions. The drawing is arranged so that positive current—a convention—flows down. **Fig. 9B** shows the diode in series with the load, so that its voltage subtracts from the zener voltage. They seem to be pointed in the same direction, but the current flows against the zener and with the diode. This is certainly confusing and will require some careful thinking. Try it; make your mistakes on a breadboard where they show clearly and are inexpensively remedied!

Amplified zeners

Being relatively high priced and having rather large tolerances, zeners may seem rather useless to many amateurs. But a small, inexpensive zener can be combined with a transistor, making a simple two-terminal circuit that will stand in very well indeed for a 50-watt or even larger zener. This particular transaction shows an unusual measure of profit: besides greatly reduced price and substantial easing of power limitations, dynamic resistance may be improved and becomes little affected by using diodes in series with the zener to build up its voltage. The effects of temperature upon voltage are increased but this will rarely be important. The current handling ability is multiplied by the transistor β, but the temperature drift is only that of the individual diodes in series.

For instance, a Texas Instruments 2N251A at $2.25 plus a General Electric Z4XL6.2 at 75¢ adds up to $3.00 for a shiny new, somewhat adjustable zener, rated about 50 watts depending on the beta of the transistor. This is comparable to the 1N2804B, priced at

Fig. 10. Schematic of an amplified zener. It's all there!



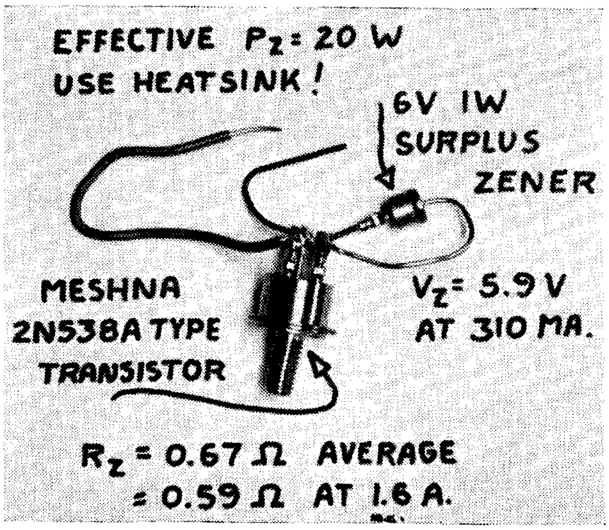


Fig. 11. A real amplified zener, and its measured characteristics. This one is good for about 20 watts. Made of junk box parts, its estimated cost is 50¢.

$10.65. That's what makes amplified zeners interesting!

The complete circuit is shown in **Fig. 10.** It does seem rather bare in comparison with most transistor circuits, but everything that's really required is there: one zener and one transistor. This two-terminal circuit closely resembles the emitter follower regulator, and if a resistor were added from the zener diode/ transistor base connection up to a higher voltage to ensure liberal zener current, it would be an emitter follower regulator. But the resistor can be omitted if the amplified zener's knee region is avoided, and then the current divides between the transistor and the zener according to the beta of the transistor.

An amplified zener is shown in **Fig. 11.** This one costs an estimated 50¢ and gives very good test results. Its knee region seems to end at about 4.2 mA and the actual zener diode is not overheating at 1.6 amps regulator current. A current increase to about 1.6 amps boosts the voltage from 5.6 to 6.8 volts, for an average dynamic resistance of 0.67 ohms. Using the voltage-divider method and hum input-output measurements, its dynamic resistance at 1.6 amps is 0.59 ohms. The very best zeners are little better than that. There is one hidden pitfall: the transistor's leakage current increases with temperature. This extends the knee region to higher current values.

This is how the current division works out. There are only two terminals; the current must go in one and out the other. It takes two routes in between. Suppose the base-collector zener is carrying m milliamperes. The transistor base-emitter junction supplies this current, and as a result an additional current, β times larger, flows from emitter to collector of the transistor. The total current I is the sum of these two, so that we write

$$I = m + \beta m = m\ (1 + \beta)$$

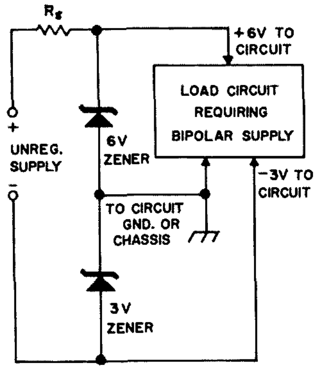
The one plus beta in the parentheses is not particularly different if we leave out the one, provided the beta is greater than ten or twenty. It usually is in a usable transistor; the difference between ten and eleven is 10%, small by electronic standards. For most purposes it's simpler yet true enough to say all of I goes through the transistor, the circuit regulates at the zener voltage plus the transistor BE voltage, and the zener heating current is I divided by β. The error is trivial.

For example, the Z4XL6.2 is rated at one watt, the 2N251A at 90 watts, and suppose a β measurement under approximate operating conditions gives a result of 50, well within specs. Remember that β is quite evanescent, depending upon collector current in addition to great variations between transistors of the same type! The maximum allowable zener current is 160 mA, since .160 amps times 6.2 volts equals the rated one watt. Then 50 times 160 mA gives a maximum of 8.4 amps current. The amplified zener regulates at 6.4 volts, since the live germanium transistor will show about 0.2 volts from base up to the emitter which is added to the zener voltage. If you really want to dissipate 50 watts, the transistor should have higher β or a 10-watt zener should be used; stay away from calculated limits!

The dynamic resistance of the amplified zener will be the inside real zener's dynamic resistance divided by the transistor β. This works out to one-fiftieth of 9 ohms: 0.18 ohms. This value is so low that the power transistor's characteristics may enter into the final result; the final value will still be well under an ohm. This result is not appreciably spoiled by adding series diodes to pad up the zener's apparent voltage.

As the current through the amplified zener is reduced toward zero, the real zener and the power transistor both weaken. The combined effects are rather uncertain, so that bread-

Fig. 12. A pair of zeners in series to provide both positive and negative voltages with respect to circuit ground, using a single power supply.



boarding with the actual components is a good, safe practice. Find the knee by measurement; remember that a capacitor across the zener will reduce its noise generating capabilities! A 6 μF electrolytic capacitor eliminated a rushing noise near the knee region in the amplified zener shown in **Fig. 11**.

Other zener applications

Zeners do not go very well in parallel. One will tend to hog the current. There is no need for parallel zeners anyway; an amplified zener will do a better job. But zeners can be connected in series to provide two or more regulated voltages. And in this case the ground can be between the zeners, rather than at one end of the power supply. If you ground both points, it won't work!

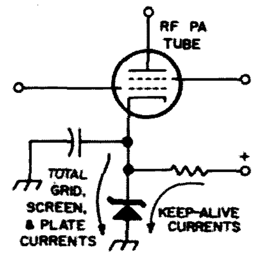
The design of switching circuits is considerably simplified if the usual collector voltage supply is supplemented by a lesser voltage of opposite polarity. The second supply is used to drain off unwanted leakage currents, turn diodes and transistors hard off, and for other applications. This relatively slight increase in the designer's armament eases many tough circuit problems. By using a pair of zeners in series, the desirable pair of voltages can often be obtained without going to the time and expense of a separate second power supply and all its problems of cost, space, weight and regulation. **Fig. 12** shows how simple this arrangement is.

Without a load circuit, the same current flows through both zeners. If some current is side-tracked around either zener, the voltage across it remains constant. The regulation isn't disturbed at all if some current is taken out around both zeners, and this is the normal application. The usual considerations about starving and overfeeding zeners are applicable here, and the beginning designer should remember that the two supply circuits don't necessarily require the same currents at the same time.

The zener diode shows little promise as a limiter and no schematic for this application is included. Ordinary diodes are distinctly superior. Zeners require too high voltage: 3 volts or more. In normal circuits that's in the high-power range. The clipping should be carried out well before the signal gets this large. Also, the zener will clip at normal silicon diode levels as soon as its PN junction is forward biased. Additional diodes would be required to prevent this, unless unsymmetrical clipping were intended. Zener clipper circuits appear impractical.

The only remaining field in which vacuum tubes retain some superiority to solid-state amplifiers is large-signal rf power amplification. The zener diode can fill a very useful spot here. It can replace the cathode bias resistor, offering a bias voltage quite independent of tube current. **Fig. 13** shows a zener in this application.

Fig. 13. Zener diode biasing for an RF power vacuum tube. Bypass capacitor recommended, appropriate for operating frequency.



Because the zener acts like a battery, most of the high voltage is taken up by the vacuum tube. The zener merely guarantees the bias. It never runs down or emits corrosive chemicals, and has a lower internal resistance than the batteries used for this application in the old gear described just after WW2. If the tube is to be biased to cutoff, the zener can be supplied with enough current to keep out of its knee region by means of a resistor up to the high voltage or over to the adjacent transistor circuit which should be providing the rf to the power amplifier. The zener should be bypassed for rf.

Zener meter

A zener diode can be wedded to a meter circuit with very useful results. To understand the utility of this match look at the usual linear meter scale. Suppose it reads to 20 volts. A one-volt reading will be way down at one end, and a lower range is required to make it readable. A small change huge percentage increase at the low end equals in scale space a small change tiny percentage increase at the high end. That's not a very equitable distribu-

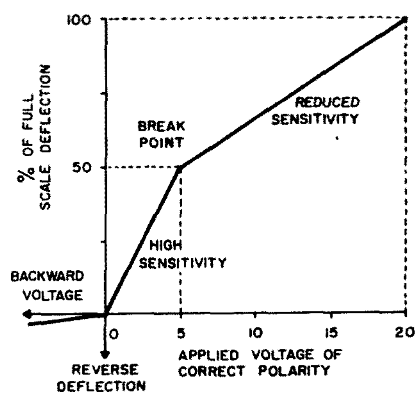


Fig. 14. How an improved meter might be calibrated to show small and large voltages with comparable accuracy. Reverse voltage does not bang the needle backward.

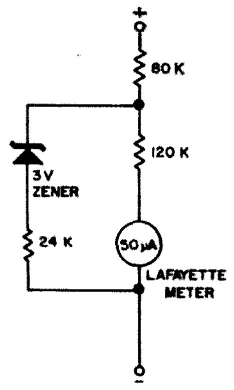


Fig. 15. A circuit that will produce the characteristics shown.

tion! For example, it would be convenient to check transistor emitter-base and emitter-collector voltages without changing ranges.

The required benefit is achieved if the circuit can be made to show variable meter sensitivity. **Fig. 14** shows a realizable result, detailed below. The first half of the meter scale is taken up with the zero-to-five volts range. The five-to-twenty volts range occupies the second half of the scale, without switching. The poor sensitivity to voltage applied in the wrong direction is a valuable by-product of scale tailoring with a zener diode.

At first glance this circuit appears to have been designed by a network expert. A closer look reveals that the values of the resistors may be deduced, one at a time, by thinking out the inside requirements of the circuit. R1 and R2 will fall first. If the meter is to read 5 volts at half scale with 5 volts applied, R1 plus R2 must come to 200kΩ since this will pass the required 25 microamps. The Lafayette meter's resistance of 1kΩ is insignificant in comparison to this value. Supposing at 5 volts the zener hasn't quite broken down, it must have just 3 volts across it. The voltage across R1 must be 2 volts, and at 25 microamps the resistance must be 80kΩ. That leaves 120kΩ for R2 since the pair must add up to 200kΩ. We already know the zener; the problem is two-thirds solved.

Now we proceed confidently to the determination of R3. At 20 volts applied the meter reads full scale, therefore is carrying 50 microamps. This current through R2 must bring the junction between R1, R2 and the zener to 6 volts. Now there must be 14 volts across R1 and that yields 175 microamps through it. The meter gets 50; 125 microamps pass through the zener and its series resistor. We have it! From the junction through the zener we lost three volts, by design; the remaining three volts at 125 microamps fixes R3 at 24kΩ.

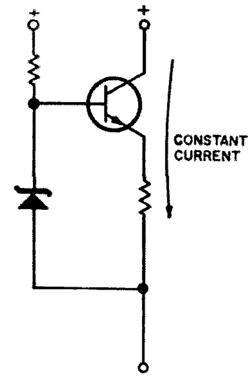


Fig. 16. A zener diode combined with a transistor to make a constant-current regulating circuit.

A breadboard check shows that the circuit behaves about as shown in the graph. This graph preceded the design, and the actual circuit is influenced by the characteristics of the zener in its knee region. Because the zener comes into conduction gradually as applied voltage is increased, rather than abruptly, the actual scale change from steep to flatter occurs along a rounded curve. A new calibration scale must be constructed empirically. That is, each point must be located by applying the indicated voltage and marking or listing the resulting meter deflection. This good idea needs further development; it requires enough current to disturb many transistor circuits.

The constant-current generator circuit closely resembles the amplified zener. Only a resistor has been added. But the constant current generator guarantees a certain fixed current, rather than the amplified zener's reliable voltage. Its operation depends on the resistor; the zener provides a reference voltage and the transistor, acting as an emitter follower, holds that voltage across the resistor. The resulting current, determined by Ohm's law, is independent of voltages applied to the outside circuit terminals if the transistor is biased into its operating range.

A working circuit is shown in **Fig. 16.** Remember that the power dissipated by the transistor is determined by its collector current and voltage, not by the values at the rest of the circuit. As in the amplified zener, if the transistor β is large enough the zener current may be ignored. The computation proceeds in this way: the 6 volt zener fixes the voltage across the resistor at 5.8 volts, because 0.2 volts is lost across the base-emitter junction of the germanium transistor. If a silicon transistor were used, the resistor would see 5.3 volts. Since a current of 100 mA is to be guaranteed, the resistor must therefore be 58 ohms. A fixed current of 10 mA would require a 580 ohm resistor since the voltage across it is held constant. But that might not work so well since the zener could be starved for current; perhaps the zener could be biased elsewhere and its voltage carried over to the transistor base.

This is an excellent circuit for eliminating hum. The hum current cannot pass the con-

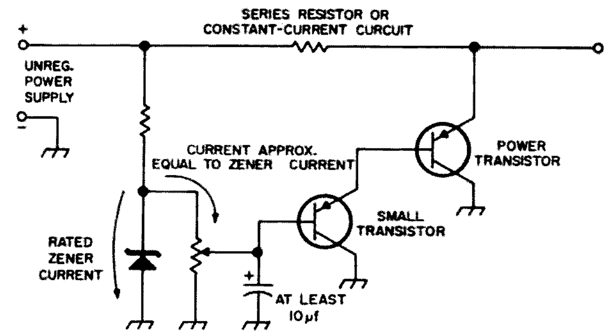


Fig. 17. A very close relative of the amplified zener. Acts like a variable zener.

stant current circuit: no hum! But before this circuit can be put to work in a usable power supply, it must be provided with an appropriate load. The fixed current will generate a large voltage across a large resistor, a smaller voltage across a smaller resistor, and a zero voltage without blowing up anything across a short. This fail-safe feature can be retained while correcting the terrible regulation problem by adding a zener regulator. The constant current is just right for biasing zeners; it is inserted in place of the usual series resistor, and a really good supply results. You should know how to do that by now!

Finally, the last circuit is a realizable substitute for a continuously variable zener. It looks very much like a Darlington pair used as an emitter follower. A current of 10 mA or so from a zener regulator puts a fixed voltage at one end of a pot, decreasing to zero at the ground end. This voltage is stable if very little current is drawn. But the current required by the Darlington pair to regulate at a certain voltage will be the through or zener-like current divided by the β of the first transistor, the result divided again by the β of the second transistor. A milliamp will determine one to ten amps! The illustrated circuit will regulate from about one to 15 volts. The capacitor is required to take out hum coming around through the zener reference voltage source. A supply using the two circuits above shows regulation as good as simple feedback-regulated supplies, combined hum and noise of about 0.6 millivolts, and adjustability over a wide range.

Surplus zeners

Zener diodes are available at prices well under par from several sources. The routes by which these zeners enter the surplus and ham markets are not at all apparent, but it seems that in many cases these zeners are rejects having no place in any electronics gear, amateur or otherwise. It also appears that some suppliers—note plural!—do not test their zeners as well and carefully as advertising statements seem to indicate.

Assorted zeners from one supplier were tested for zener voltage and dynamic resistance. Most tended to regulate in the general 20% region, but a few were drastically off. Many of these zeners, 10 watt stud mounting types priced under a dollar each, had fairly high dynamic resistance. Perhaps that is why they were available! A second collection, about 30 assorted zeners adding up to the attractive price of $10 plus shipping, appeared considerably less economical after careful checking and tests. Some were mounted backwards in their cases, many showed poor regulation, a few were phenomenally noisy, others did not zener at all, and one had a broken lead. The more expensive varieties did not seem to average any better than the cheapest ones. There is a moral here. If you are going to use surplus zeners, check regulating voltage, dynamic resistance, and noise characteristics of each zener before you put it in that nice new circuit. Don't take it on faith; the chances that it is not as indicated may be as bad as one in two.

This experience suggests that the most effective way to buy is to purchase new stock zeners, or else test before buying. It may help to initiate a general practice of testing zeners promptly upon receipt, and returning bad ones to the supplier. Be certain the test is correct! Or perhaps you have found a good source of tested surplus zeners; if so, make the most of it and tell your friends. A zener is a zener, and it's the device, not the label, that is required in the circuit.

Testing surplus zeners

A batch of surplus zeners can be tested most effectively if the operation is performed in several steps. The first pass eliminates the obvious duds, the second sorts out the remaining zeners into broad voltage ranges. A third, perhaps, determines if a particular zener can be used in a specific application.

Several instruments are required for complete testing. Also a few resistors and clip leads, a place to work, some scratch paper, and marking paint. A high-sensitivity multimeter or a dc VTVM serves for voltage measurement. Another multimeter or a milliammeter provides for current measurement. An optional ac VTVM is useful for checking dynamic resistance by the hum voltage divider method. A signal tracer will serve very well for detecting the slight hiss a few zeners show in the knee region, or the raucous racket at higher current levels indicating the zener should be discarded. Finally, a magnifying glass assists in detecting mechanical faults on

the surface of the package.

The surplus market is low man on the totem pole. It's quite safe to expect a specific zener has something wrong with it, which brought it to the supplier and then you[2]. The testing operation is a sort of detective game played to find out if the fault will or will not interfere with its use in a piece of ham gear. This game can be played most productively if the goals are known. First, does it show semiconductor properties at all? Second, what do they seem to be? Finally, does a closer inspection show they are really there, and that obvious faults are absent?

Modern technology and the manufacturers have conspired to make this game more difficult than it might be. A given zener may be a double-anode device, usable in either direction. Or it may be a zener and a diode, practically the same thing but rather different in intent. And there is a chance it is an amplified zener: a zener and a transistor in one package. The amplified zeners seen so far have been high-power devices, but this may change any time.

A first inspection serves to eliminate broken zeners, ones with bad leads, cracked cases, and other faults. An obviously abused condition is certainly grounds for rejection. At this time the wattage can be estimated by comparison with known zeners and catalog descriptions. A few zeners are shown in **Fig. 2**. Low-wattage accurate zeners may be placed in large cases for better temperature control; high-wattage zeners are indicated by the provision of some means for mounting to a heat sink.

Then the power supply is set up with its negative output terminal to ground. A resistor is placed in series with its positive terminal, chosen to limit the current to near 10 milliamperes. A 40 volt supply would require about 4000 ohms, anything over a half watt would do. The zener goes between the output end of the resistor and ground. Regardless of its condition it cannot receive more than 10 mA; this is a safe arrangement.

The first test is to measure the lowest voltage across the zener at this current, trying both directions. If there is a polarity mark or band, the least voltage should be seen when the band or "cathode" end is toward negative ground. If the voltage is under about 0.6 volts, the device is not a zener and further testing is not required. If it is in this range, and if doubling the current by halving the series resistance from the supply produces only a small increase in voltage, the device is showing proper characteristics for a forward-biased silicon PN junction. If this cannot be achieved, it may be a faulty device, or it may be one of the more complex varieties, mentioned but otherwise carefully avoided in this article.

A breakdown test is now appropriate. The cathode end is turned toward the positive supply, and a measurement of voltage gives the approximate zener regulating voltage. If the resulting voltage is the power supply voltage, then no current is flowing and the device may be a rectifier whose inverse voltage, or a zener whose breakdown voltage, exceeds that available. A current doubling should, again, have very little effect on the stabilized voltage. This test indicates that the device shows zener characteristics.

Knowing the approximate zener voltage and wattage, the supply circuit can now be revised to bias the zener to anticipated normal operating conditions. At this time the dynamic resistance can be estimated by the hum reduction method or by the voltage change over current change method. Typical values for test current and dynamic resistance are available from most catalogs.

If the extra lead is not objectionable, the signal tracer can be left attached to the zener during these tests. With practice, good zeners can be sorted from bad ones almost by ear alone, on the basis of hum and noise. But if this has not been done, a final check for noise should be carried out. Raucous, splattering noise indicates immediate disposal of the zener. A fine-textured hiss at low current levels is permissible, unless it shows a tendency to increase with time or current. Larger zeners should be firmly rapped with an insulating rod to check for loose internal connections.

Zeners that have passed all tests might be marked with fast-drying modeling paint, in resistor color code, as to their values. The paint will also serve to indicate that they have passed a fairly comprehensive test.

. . . W2DXH

[2]Of course, many zeners reach the surplus market as manufacturers' over-run, production ends, etc. These zeners, which are available from many suppliers, are generally good, new diodes. *Ed.*

Bibliography

There is not very much literature available on zener diodes. Most of it tends to be rather condensed for engineering purposes. If you can find some to read, don't hurry. The usual engineering training includes lots of math and theory, so that the brief accounts carry much more information than at first meets the eye. Try to find more than one of these:

1. Millman & Taub: *Pulse, Digital and Switching Waveforms.* McGraw-Hill, 1965, p. 185-189.
2. Cutler: *Semiconductor Circuit Analysis.* McGraw-Hill, 1964, p. 564.
3. Surina & Herrick: *Semiconductor Electronics.* Holt, Rinehart & Winston, 1964, p. 304-312.
4. Littauer: *Pulse Electronics,* McGraw-Hill, 1965, p. 120-121.

Also see:
Motorola *Silicon Zener Diode and Rectifier Handbook.*
International Rectifier *Zener Diode Handbook.*

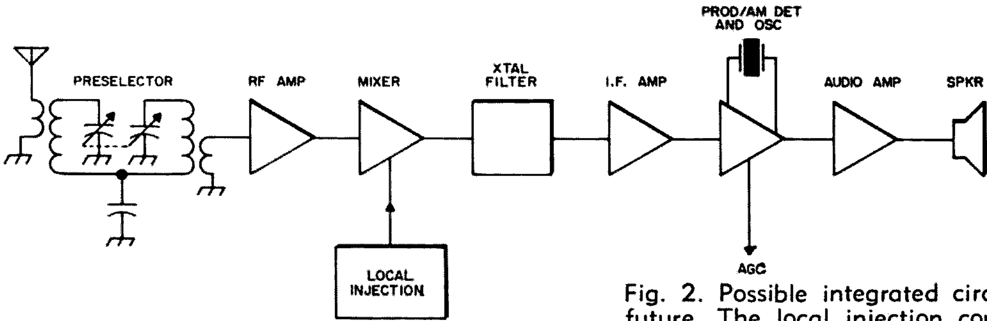


Fig. 2. Possible integrated circuit receiver of the future. The local injection could be a frequency synthesizer or conventional oscillator.

(Continued from page 4)

tional components. But these schematics look very odd to a person used to conventional tube or transistor circuits. They seem to contain an awful lot of transistors. There's a good reason for this. Transistors are the cheapest IC components to make—and they take up less area than other components. Low-value resistors (it's difficult to make resistors over 50 kΩ with monolithic IC's) are next smallest. Capacitors take up the most area so they are most expensive components to make. Since IC chips are small, capacitors over 500 pF are rare. So far, no one has developed a practical way to make IC inductors, so coils have to be outside the IC package.

These facts have meant that IC designers use as many transistors as possible and few resistors and capacitors. This is quite different from conventional practice, but isn't necessarily a disadvantage—once you become familiar with IC practice.

Devices using integrated circuits are usually simplest when they use two power supplies, one with a positive ground and one with a negative ground. This helps avoid the complicated bias networks and large decoupling capacitors that would otherwise be necessary with so many interdependent transistors.

Linear or digital?

In terms of use rather than construction, there are two types of integrated circuits. *Digital* IC's are the multivibrators, gates, counters, dividers, and so forth used in computers. Most engineering attention up to now has been focused on these digital IC's since they can simplify the construction of computers tremendously. Digital IC's have many possible ham uses: keyers (such as the Kindly Keyer in the July 73 and the Micro-Ultimatic in the June 73. Both of these keyers use very inexpensive Fairchild epoxy-case IC's: $1.50 and 80¢ for example.), dividers (as for getting 1 kHz markers from a 100 kHz crystal standard), counters (frequency meters that count the number of cycles per second), control circuits, mixers and detectors. Expect 73 articles on these topics in not too long.

Linear IC's are the other type of integrated circuits. They are amplifiers. A simple six meter converter using linear IC's was described by W3HIX in the October 1965 73. Until recently, linear IC's have been very expensive. However, the prices are dropping rapidly so we can expect to see more and more of them in hi-fi sets, radios and TV's. In fact, one RCA TV set already uses a single linear IC for its sound *if* amplifier and GE has just announced a linear IC for less than $1.00 in quantity.

Linear IC's are used in applications familiar to every ham, unlike digital ones, so linear IC's seem more interesting to most of us. They can be used for amplifiers, oscillators, mixers and much more.

IC's are of many types. Some are simply conventional amplifiers in small packages, but the most interesting and promising ones are quite different. The basic configuration for many IC's is the differential pair shown in **Fig.** 1. This circuit was chosen because it's very versatile, uses few high-value resistors or capacitors, and has excellent temperature stability since the transistors are matched. Differential amplifiers can be used as oscillators, amplifiers from dc to VHF, linears, frequency multipliers, mixers, product detectors, signal generators and so forth. They can be used in either push-pull or single-ended, and can easily be adapted for squelch or gain controls.

The constant current source shown in **Fig.** 1 is usually included in the IC. It consists of a transistor regulator and a few diodes. Emitter followers, cascade amplifiers and other refinements are often included in the IC to increase gain or input impedance or for other reasons. Lots of terminals (10 to 14) are connected to vital points in the circuit so that the IC can be used in many ways: ac or dc input or output coupling and AGC or squelch terminals, for instance. IC's come in small (¼" x ½") flat packages and in cases similar to transistors.

IC's are made in widely different configurations, gains and frequency responses. They are made for many uses. Most are consider-

ably more complex than the one shown in **Fig. 1.** A typical linear amplifier is the RCA CA3005. With external tuned circuits, it can give 20 dB of gain at 100 MHz with +6 volts on the collector end and −6 volts on the emitter end.

How Will IC's affect ham radio?

Ham *operators* will benefit from the IC's that turn up in their commercial equipment in a number of ways: increased reliability, more features, better performance, smaller size, less weight, lower power consumption—and lower prices. It probably won't be long before we see IC's in ham equipment made by progressive manufacturers. A single IC can replace the tubes, transformers, resistors and capacitors associated with them in a conventional *if* amplifier: Selectivity in modern equipment is generally provided by crystal or mechanical filters, but the spurious responses that sometimes pop up in odd places with narrow-band filters could be a problem. Nevertheless, they can be taken care of. In fact, the tremendous cheap gain available with IC's means that resistor-capacitor shaping and feedback networks can provide considerable selectivity, even at 455 kHz or higher.

IC detectors and audio amplifiers also should become popular in not too long. It'll probably be a bit longer before IC's are used in rf stages. They can't reduce the size of front ends too much, but they do have some features to offer. The low noise, high gain and high input impedance of IC's means that designers can build fairly high selectivity into the tuned circuits before the first rf amplifier. IC's can also give exceptional AGC without complicated external circuitry.

The ham *builder* will find that integrated circuits hardly end his fun. Most IC's now available are building blocks, not complete units. They can be put together in many ways. Soon IC's will be very cheap. They're already easy to wire up. In not too long we'll be able to use more complex (and desirable) circuitry than we've tried in the past, yet still have inexpensive and easy-to-build equipment. We have plenty of building to do before we all become operators (or TV watchers) instead of experimenters and builders.

The future of integrated circuits is very bright. They have plenty to offer all of us. Learn a little about them now so you won't be lost as they become more popular. Don't stand in the corner with your back to everyone crying "Tubes forever!" (or even "transistors forever!") until you've been passed by.

. . . WA1CCH

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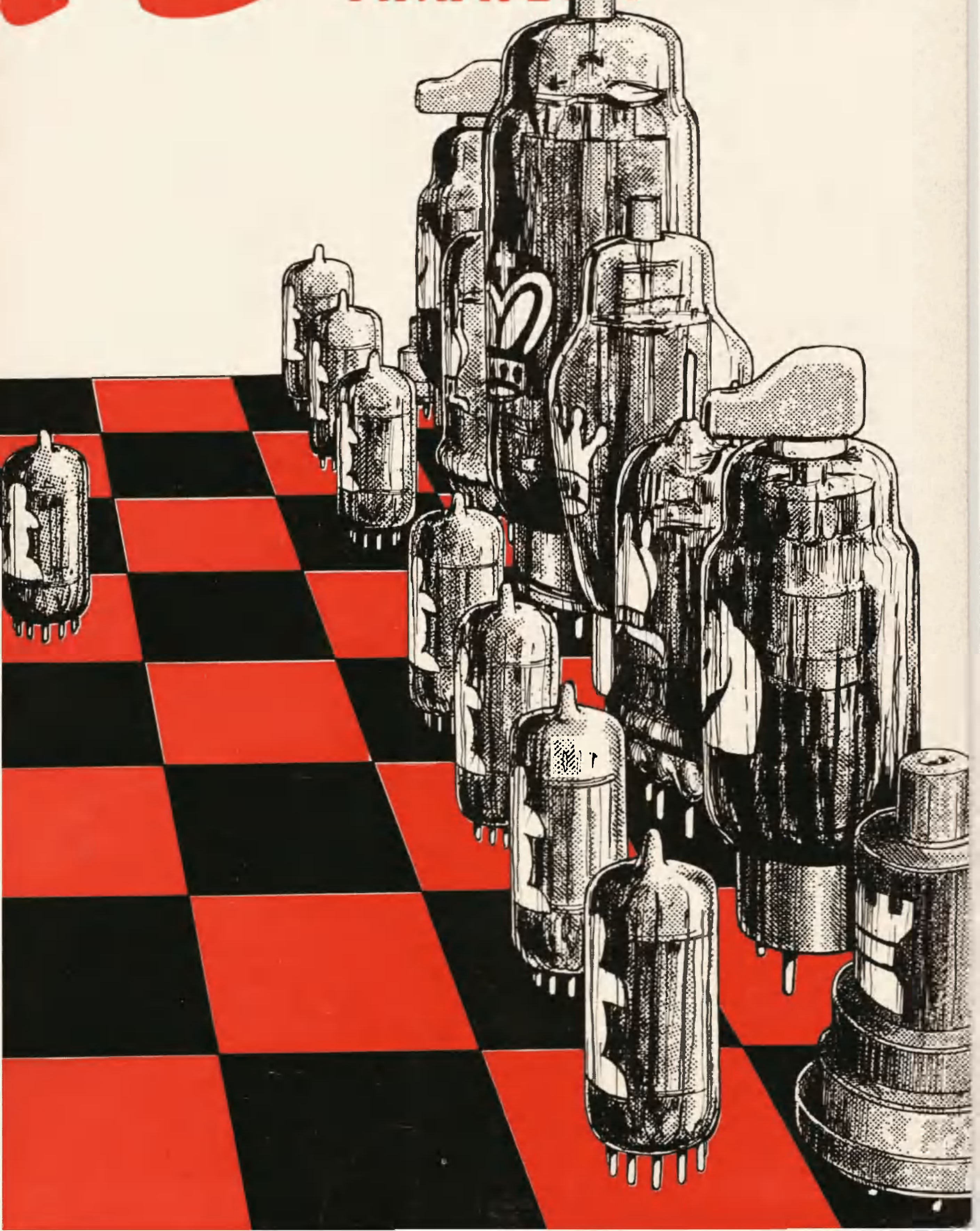
73 AMATEUR RADIO

NOVEMBER 1966

A Thankful 60¢



73 Magazine

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Postmasters, please send form 3579 to 73 Magazine, Peterborough, New Hampshire. Why not make a DX friend of yours happy with a gift subscription to 73?

de W2NSD/1

never say die

Last month I wrote describing the first few weeks of my trip . .. the fun side, with hunting and safari in "darkest" Africa. This month I'd like to tell you about the more serious side of my trip . . . my visit to six African countries and eleven Asian countries.

Since the balance of power in the ITU has changed to the Afro-Asian countries and the survival of amateur radio through the next ITU frequency allocation conference is largely dependent on the support we will get from these countries. I wanted to find out as best I could what the amateur radio situation is in these countries and perhaps what might be done to improve it. I wanted to find out just how much amateur activity there was, how much of it was by Europeans and Americans, and how much by locals. I wanted to find out what the possibilities were of getting more local operators and what, if anything, could be done to help expand amateur radio in these countries. I wanted to find out what sort of support amateur radio is getting from the governments of these countries.

After visiting these seventeen countries and talking with the leading amateurs in these countries I think I see a fairly clear pattern. While the picture looks, on the surface, very black indeed and I found virtually no amateurs with any word of encouragement about our future, I believe that, even though the time is desperately short, we can accomplish enough in the time left to us to give us a chance at survival.

Our basic problem is not that the governments of these countries are against amateur radio . . . our difficulty is that they are almost completely ignorant about it. I don't know if I can get across to you the vacuum here. For instance, I was talking with the Minister of Communications for a country . . . this is the top man who is responsible only to the Prime Minister. This chap was under the impression that amateur radio had to do with taxi two way communications, ship-to-shore radio, doctor calling services and the $10 C-B handtalkies he had seen advertised in America.

Our strong point with all of these countries is that they need amateur radio . . . they need it badly . . . desperately. The weak point is that they don't know they need it. The job that has to be done then is twofold . . . first we must make them aware of the tremendous importance of amateur radio to their countries and secondly we must work with them to nurture it there.

You know, it's funny, but I've found that though most of us realize the value of amateur radio to our countries, few of us bring this point up when we have an opportunity to put in a good word in the right place. We tend to brag about the much less vital benefits of our hobby such as our ability to provide communications in time of emergency, our value as a training ground for military needs, our propaganda value in our contacts with other countries . . . tourism, etc. All these are undeniable benefits that a country derives from amateur radio . . . but the one single most important point is often missed.

One of the most fundamental and important needs of any country that is trying to develop is communications. A country can only develop as fast as its communications permit it. Communications is absolutely basic. Without communications you don't have business, you don't have government, you don't have a country. And without people to build, install, operate and repair the communications you don't have communications.

The key to providing the people for communications is obviously amateur radio. Our hobby provides the spark of interest which attracts fellows in their teens into communications and electronics. In practice we find that at least half of these who get interested in amateur radio eventually go into electronics and communications. We find that a country that encourages amateur radio automatically develops a generous supply of self-trained and interested men who are ready to help the country grow. When there is an adequate supply of amateurs in a country there is no need to bring in outside experts at high salaries or to set up expensive state-run technical training courses which produce men with book learning and no practical experience. Further, the amateur does not turn out to be the technical graduate who will never sully himself by actually working with equipment. He knows the gear . . . he has worked with it and he jumps in when something has to be done.

It is no wonder that the countries, without

(Continued on page 108)

Editor's Ramblings

Paul Franson WA1CCH

Zip

We have completed the work of adding zip codes to all of our U.S. address stencils. It cost quite a bit, but we're happy to do this if it means that we'll get better mail service and that postage rates won't go up.

All of our stencils are now arranged by zip codes, so whenever you write us about your subscription, we *must* have your zip code. Please don't forget this very important part of your address.

We'd also appreciate your checking your address label to make sure that the zip code on it is correct. It's very difficult for us to check them here, and the Post Office may not deliver your magazines after the first of the year unless the zip code is correct.

We are also installing an IBM data processing system to improve mail deliveries, our handling of subscriptions, and our bookkeeping. We expect it to speed up all of these things after it's working properly. The first issue of the magazine we will mail with this equipment will probably be the February issue, the first mailing in 1967. We're hoping that the change from our present system, which we've outgrown, to the new one will be smooth and orderly. Realistically, we imagine some problems will probably pop up and hope that they won't be too rough.

Changes in 73?

73 readers often ask us "when" we're going to change to the square-back "perfect" binding used by QST and CQ. The obvious implication of their question is that perfect binding is superior to the binding we now use, which is called saddle stitching. I'm not so sure that they're right. Maybe this is a good time to discuss the two bindings and point out the advantages and disadvantages of each.

Saddle stitching offers a number of advantages: The major two are that it's cheaper and faster to bind this way than to perfect bind. These two considerations alone have made saddle stitching very popular with weeklies and other timely magazines such as Newsweek, Saturday Review and Business Week. Saddle stitching seems more up-to-date than perfect binding, probably because so many very popular, "in" magazines such as Playboy, Scientific American, Car and Driver and the New Yorker, use it.

Saddle stitching offers two big advantages to advertisers. Saddle-stitched magazines tend to fall open at their center, giving the advertiser who takes the two center pages of the magazine extra reader attention. That's only good for one advertiser per month, though. But all advertisers who take facing pages (called a spread) find that their ads are more impressive in a saddle-stitched magazine than in a perfect-bound one.

But the advantages listed above mean little to the average readers of a magazine. They help advertisers and publishers, not readers. The big appeal to readers of a saddle-stitched magazine is that it permits the magazine to open flat. 73 stays open when you're trying to build a project from it without the traditional two transformers. If this seems a minor item to you, you must not do much building. For that matter, many people have devised gadgets to hold QST open in the workshop.

Various advantages of the square back (perfect) binding, like those of saddle stitching, are important to different people. For the person planning a magazine (in this case, me), perfect binding is much more versatile. It's far easier to handle booklets and other inserts and special color arrangements with perfect binding since a perfect-bound book is made of a number of smaller booklets bound together. A square-back magazine looks thicker and more substantial than a saddle-stitched one of the same size, as you can see if you compare a recent CQ (112 pages) with a 73 (128 pages). The smaller CQ *looks* thicker. The square back also makes a convenient surface for printing the issue number, so that it's easy to find a particular copy in a random stack. However, most people who keep old magazines for reference keep them in binders, so that this doesn't seem to be very important.

I think that the main reason so many hams (especially older ones) prefer the square back is that they're used to it. After all, QST and CQ have always been that way, so all ham magazines should be the same. We've run into that attitude about many other things as

(Continued on page 120)

Bill Hoisington K1CLL
Peterborough, N.H.

80 Watts on Two Meters for $80

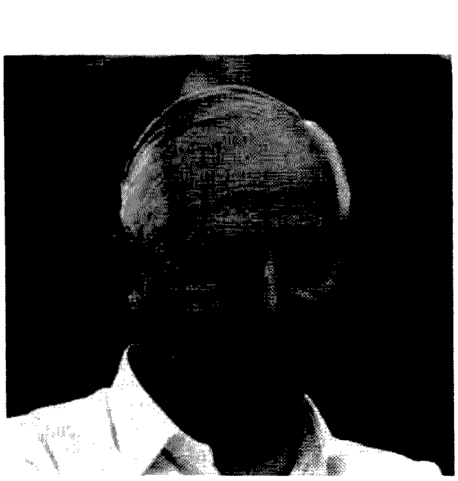
Here's the two meter version of Bill's very popular 50 watts on 50 MHz for $50 in the June 73.

We all know superhet receivers—well, here's a superhet transmitter, in fact three of them. Two work poorly, but one works very well. It uses a rock-bound VFO! It's easy to build and low in cost. You too can build it, but just pay attention to all the little details.

The problems facing the superhet transmitter designer are much the same as those that bedevil the multi-conversion superhet receiver man, but in reverse!

1. We have transmitting images instead of receiving images, licked by moving the oscillator further away from the desired frequency.
2. We also have oscillator instability and oscillator hum modulation, to be cured by putting the variable oscillator down on a low enough frequency, which means not higher than ten meters, and preferably much lower, like 3 to 5 MHz, and then *adding* it in, not multiplying it.
3. This last remedy demands more than one conversion to get on two meters for a no-compromise job. Sounds familiar?

If you try to do it with only one conversion, you have to accept compromises and be careful in your crystal and frequency choices. Or use more tubes. Or think about new circuits such as the tripler-mixer. It can be done, but you may not like some of the results. The first two transmitters are interesting, but partially unsatisfactory, but the third described is almost perfect!



Difficulties met on two meters

The two meter designer meets many more difficulties on two than on six. These stem mainly from the higher frequency. If you use the same type of crystals (that is, no higher than 40 to 60 MHz) you have to use a stage of frequency multiplication. The reduced circuit gain experienced at two meters requires more amplification (more tubes) to reach a given power. And this is more trouble on two as tubes begin to show their transit-time losses and lower input impedances.

In spite of this, or you might say because of this, I spent considerable time and effort in developing this circuit to keep the number of tubes at a minimum. I developed a brand new circuit (at least to the best of my knowledge) but its rf output was too low.

Details are important on two meters: the amount of gain per stage, how to conserve this gain, grid tuning, practical low cost construction, and so forth. So pay careful attention.

One tube, two meters

Here's my one compaction, crystal oscillator, VFO, tripler-mixer, with two meter output. (Do *not* build this one. A better circuit is de-

---

Bill Hoisington K1CLL, former W2BAV and 2BAV is well-known to all 73 readers for his many construction articles on VHF and UHF gear. Bill has been licensed since 1923.

scribed later.) But believe me, this was *not* done for a stunt! I decided to keep the VFO feature at all cost for two meters. It's not yet an absolute necessity at all times for getting a QSO on two, but there are lots of times when you cannot make a desired contact without the VFO. If you set up the rig in a different location, or on a hill-top, and hear some local lads chatting away, where are you without VFO? This occurs plenty at home also.

The 6AF11 works fine as two separate oscillators and a mixer, with its two triodes and one pentode. Where oscillators on separate frequencies are deliberately coupled to a mixer, there is no nuisance reaction between sections. I say nuisance advisedly because when used for certain other purposes there can be nuisance reaction, such as, for example, when trying to use one of the triodes as a low level audio stage and one of the others as an oscillator.

Every time I use the "video" type pentode of the 6AF11 as a mixer with crystal controlled energy on the grid and low-frequency variable addition frequency on the screen it works like a charm.

However, in going to two meters using the same tube layout as on six, plenty of difficulties showed up right away.

I did not want to go to a crystal of over 100 MHz (too expensive and too touchy) so had to frequency multiply. But that used up the two triodes right away! After spending some time on the bench with an external mixer, with much poorer results, I suddenly hit on the idea of using the tripler as a mixer also.

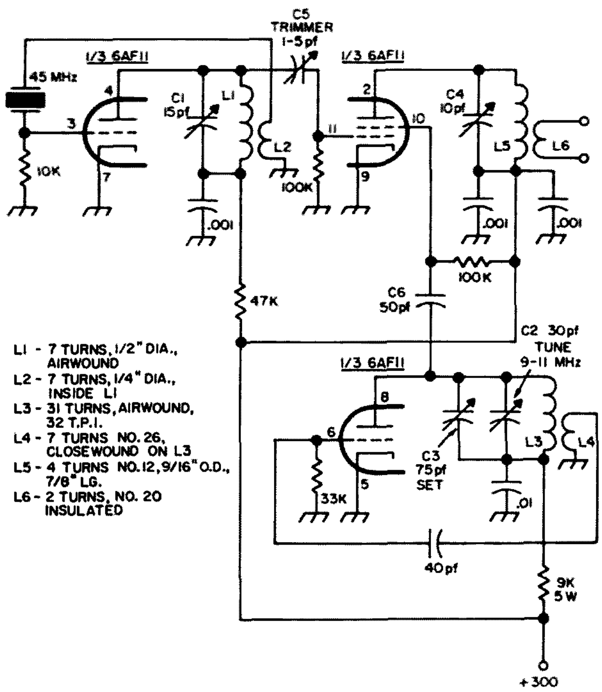


Fig. 1. Compoctron crystal oscillator, tripler-mixer, and heterodyne VFO with two meter output, from one tube. This circuit is not recommended. It gives enough drive for a 5763 amplifier, but not for an 80-watt final.

Well, why not? Plenty of triplers on VHF-UHF have been modulated by voice (and other things!). So, I fed 45 MHz into the grid and modulated the screen with low frequency from the other triode used as a 9 to 11 MHz oscillator, and lo and behold, just as theory predicted (this time theory worked) out came one of the "side-bands," none other than 144 MHz. It was nice and stable to adjust from

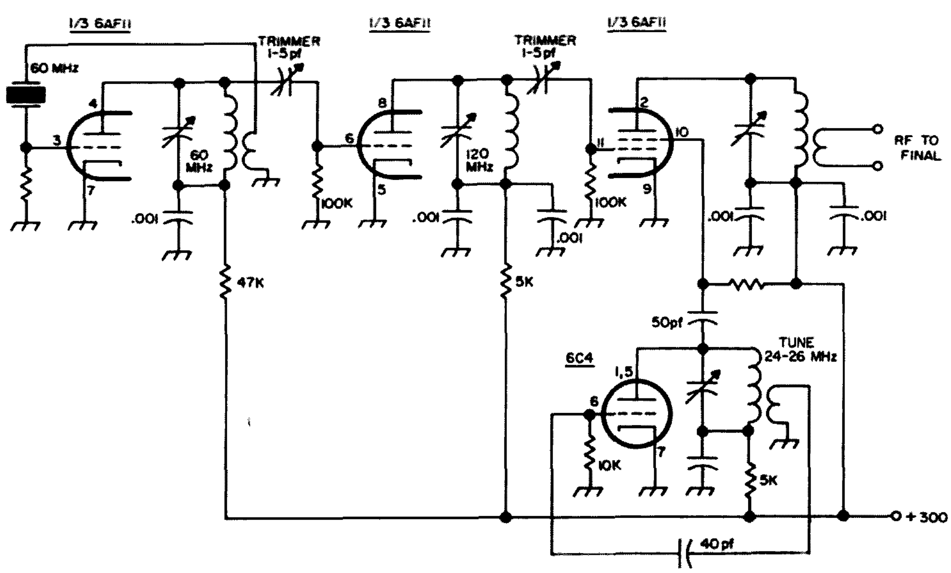


Fig. 2. Single conversion heterodyne mixer for two meter output. Plenty of output to drive a 7984 final, but not enough stability and too much FM'ing. Don't use it.

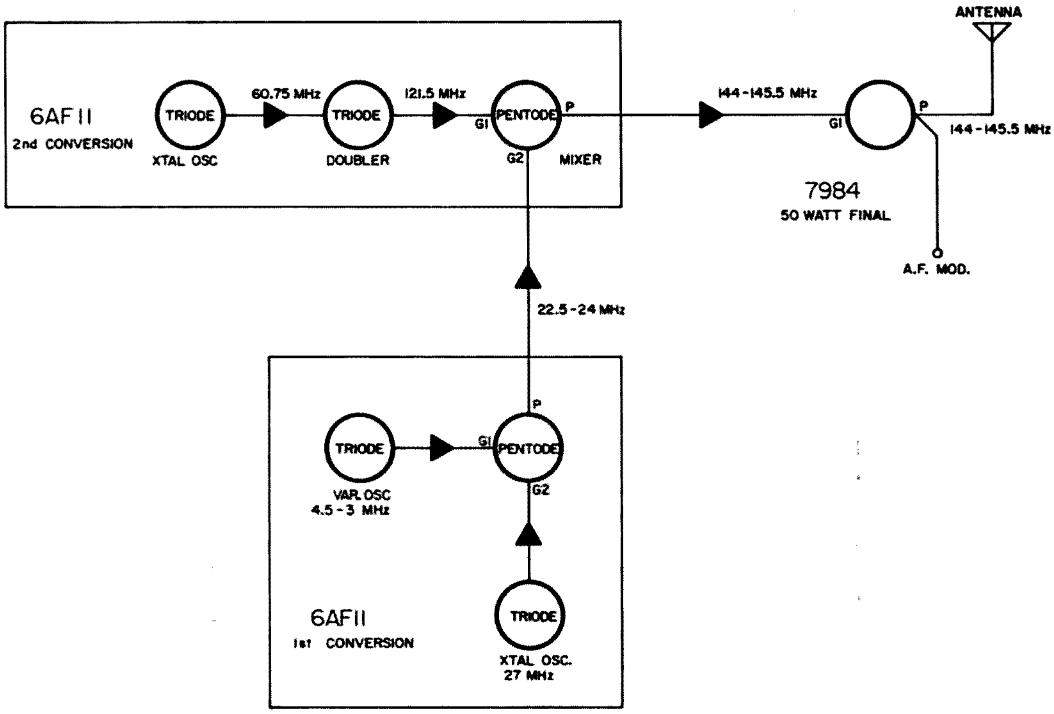


Fig. 3. Block diagram of the "perfect" two meter, superhet, double conversion transmitter. The first conversion is given in Fig. 4, the second conversion in Fig. 5, and the final in Fig. 6.

144 to 146, but had less than 100 mW output.

The circuit is shown in **Fig. 1.** It is really quite clear if you simply follow through one "tube" at a time. The 6AF11 is actually just three complete tubes in one glass bottle, so it isn't hard. You can dimly light a number 48 bulb on the output terminals with about 280 to 300 volts B plus.

However, while the two meter output was enough to operate a 5763 amplifier, it only gave marginal drive for the 80 watter. I have followed one principle above all others in my articles. NO MARGINAL CIRCUITS! It's bad enough for lads with not too much experience as yet to get a *good* circuit going. If a circuit causes *me* trouble after 40 years experience it must be marginal. Anyway, don't build the above circuit, unless you really like to play around.

Second superhet transmitter

This also is an *intermediate* design. It's good, but not perfect. If you want a stable VFO transmitter with two tubes for a total of $3, which will drive an 80 watt final amplifier with only one conversion, you can use this one. But it's intermediate: good, but not perfect.

Fig. 2 shows the circuit. One of the 6AF11 triodes is a 60 MHz crystal oscillator. The second triode is a doubler to 120 MHz. The pentode section of the 6AF11 mixes 120 MHz from the doubler with the 6C4 24 MHz VFO.

That's just about it. The pentode plate is tuned to 120 plus 24 MHz and there you are on 144 MHz. With a single 300 volt supply from an old radio you can burn out that number 48 bulb (120 mW) on two meters, but when I put it on the air, I met the Gremlins! Everything *looked* fine: Plenty of drive to the final, tuned fine, image 24 MHz away, (couldn't even find it), modulation great, first contacts fine. But, as soon as some sharp receivers were encountered drift and FM were noticed. There's no getting around it, you should use more than one conversion on two meters—both on receive and transmit. So, enough of that, let's get on into the "perfect" job.

Third try—and success

This is the one. No compromise here. You throw on the exciter and Plonk! Right in the middle of the sharp pass-band receiver (both yours and his) each time. No drift, no FM, and you can operate anywhere you like from 144 to 146 MHz. **Fig. 3** shows the block diagram. The conversion circuit of **Fig. 2** is retained but the external 6C4 variable oscillator is replaced by the first conversion 6AF11 shown in **Fig. 4.**

A 27 MHz crystal starts the ball rolling. Cheap 27 MHz CB crystals are fine. Of course, you can use frequencies to suit, with other crystals, if you have them. The important point to get is the *general* range of frequencies you *can* use. It's a good rule not to go over ten times in frequency, when converting,

either on transmission or on reception. This also holds for frequency division, subtraction, or addition. You *can* do it if you *have* to but then you have to get quite fussy and use elaborate filters, etc.

Note carefully that the first conversion uses *subtraction* instead of addition. If you have a rock 3 to 5 MHz *lower* than 22.5 or use a different second conversion frequency you can *add*. Just don't stray too far from the indicated frequency. Say 110 to 125 MHz for the second conversion and 19 to 34 MHz for the first.

The second triode is the low frequency oscillator. Note that with subtraction instead of addition you tune to 4.6 for 144, and to 3.6 for 145 MHz. Learning these tricks will be useful for you in years to come, if SSB takes over completely.

No special precautions are needed on the VFO when using double conversion. Haven't used a voltage regulator yet.

This low frequency oscillator feeds into the pentode screen and there you are out on 22.5 over to the second conversion. I used a link, L5, over to the second conversion stage because while L4 on 22.5 does tune nice and sharp, there are other frequencies in there to keep down. Such as the crystal on 27 and the plus frequency on 31 MHz. Also I'm using at present an untuned grid on the final. Use a number 48 bulb link coupled to L4 to tune up, also use a wave meter. Check for 22.5 to 24 MHz and you'll be doing fine. If you use different crystals than I did you will check for

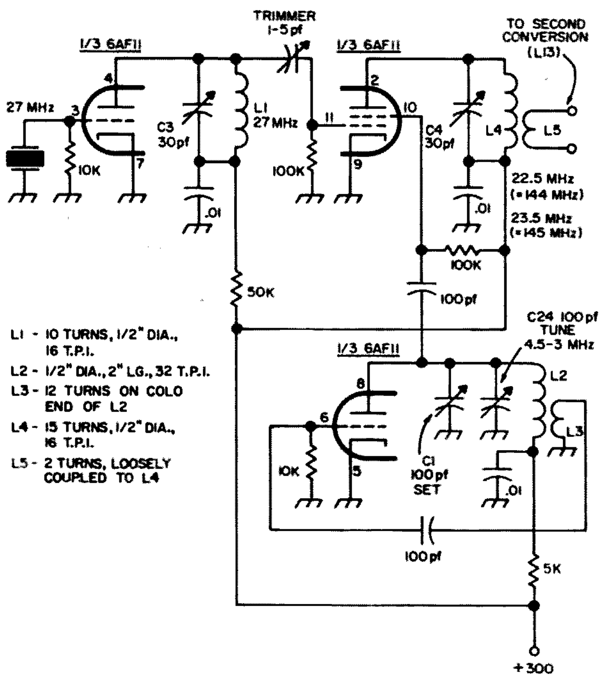


Fig. 4. First conversion section of the ideal transmitter. It puts out a stable signal on 22.5 to 23.5 MHz.

the corresponding points of course. The bulb should *almost* burn out. A brown head .9 watt or a blue bead 1.5 watt bulb can also be used.

The second conversion is shown in **Fig. 5.** I used a 60.75 MHz crystal because it was in the junk box. And it worked fine. As mentioned above, you can use others but I would advise staying in the 55 to 65 MHz range for doubling to 110 to 130. With a little regeneration from L11 the 60.75 rock takes off every time and the circuit has plenty of output and handles just as well as any lower frequency crystal. You will need a regenerative connection in the crystal grid circuit, the plate on one end of L10 and grid on the other end of L11. Use a tuned diode to check for 60 MHz output from L10.* C5 should be coupled lightly at first to the doubler grid, then advance C5 for more drive to the doubler. You will find that C5 at maximum will overlead the crystal oscillator. Be sure to adjust C1 so that the oscillator starts every time. This condition does not occur at maximum rf output but backed off a little.

This 60 MHz output goes to the doubler grid, whose plate is tuned to 121.5 by L12 and C12. The pentode input capacitance is sufficient for parallel resonance without any capacitance across L12. I did have one there but removed it.

The 22.5 MHz variable frequency input from the first conversion is link coupled by L13 to L14 and applied to the pentode screen by C14. Vary the coupling of this link for full drive to the screen with the least possible coupling. Just in passing, everything went smoothly in this circuit. This has almost always proved true. Try to *cut down* on components and you run into trouble. Put in the stuff necessary, and it goes good.

So, after tune-up, the 121.5 and the 22.5 add in this pentode and come out on the plate as 144 MHz. Be sure to peak up on *144*, not 121.5 MHz. You can also find the 121.5 minus 22.5 MHz, if you look for it, but it will be no trouble.

You should have about 85 to 90 volts on the plate coil of L10 in the operating condition. Do not go over this voltage as those VHF crystals are nice and stable as long as you keep *under* 100 volts on the triode plate.

You will find about a half watt or so out on 144, enough for that big final. Well, it is big for Two'er or Gonset lads.

The 80 watt final

A previous model of this one was described in the July '66 73, so we'll just touch on the improvements here. **Fig. 6** shows the circuit.

* See p. 20 in June '63 73.

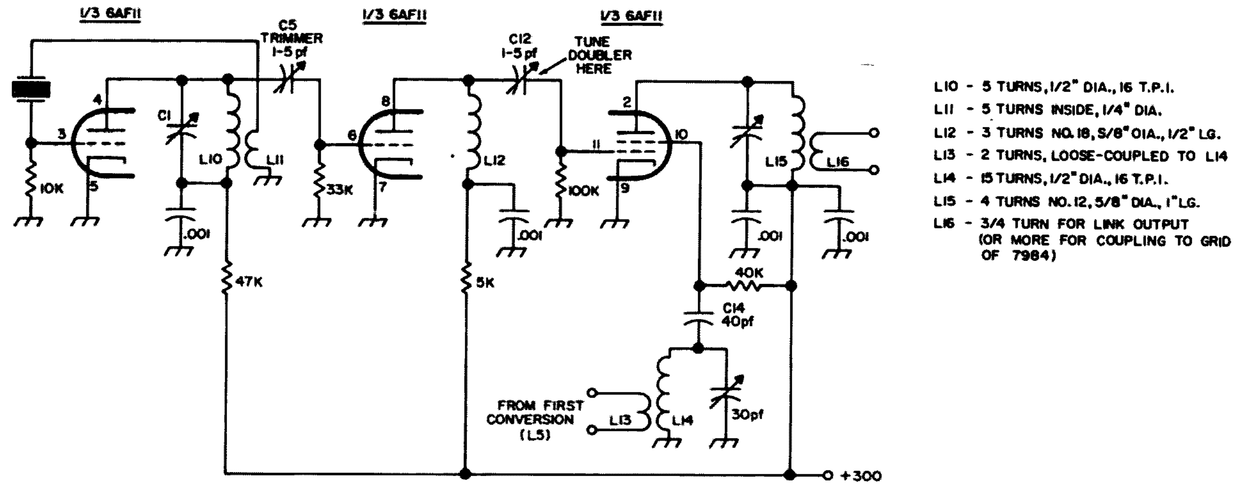


Fig. 5. Second conversion of the two meter transmitter. An input of 23 MHz from the first section gives output on two meters. The crystal used is 60.75 MHz. Output is about half a watt.

The grid circuit is simplicity itself but does warrant some discussion. The input capacitance (and some usually unmentioned inductance) reduces the size of any ordinary lumped inductance you might wish to put in as a "grid circuit." The choice for now is a quarter wave fixed tuned tank as shown in **Fig. 6.** A full wave circuit was tried but so far was not any great improvement, other than to allow link coupling, which you cannot use with the quarter wave circuit shown. It tuned nicely but showed signs of self-oscillation. If you remember, neutralization had to be used in the six meter unit. Note that the amplifier must be next to the exciter.

By simple cut and try the grid coil was worked out. This puts the grid on 144 MHz, fairly broadbanded, and works like a charm. Through the 25 kΩ grid resistor, there is about 1½ mA of grid current. Try for 2 mA

A real good plate dip is obtained along with a zippy noisy arc from a pencil test on the plate while dipped from 200 mA to 50 mA or so. This not quite the roaring flame you get. with the switching six and two 200 watt final with the 4X250 (see 73, April 66) but it does light a 50 watt bulb to dazzling brilliance.

And reports on the air are all good. Modulation was provided by the old standby with a pair of 6L6GC's. See June 73, page 20.

Reports were "At least 100% modulation", "Clear", "Excellent", etc. Stability was checked with a number of QSO's, one with a receiver (with 2 kHz bandwidth) receiver 40 miles away. Anyway, on selective receivers it comes right on at the same frequency every time. And last night I had the opportunity of checking with a Collins 75S1 and over some ten minutes he had not touched the receiver dial.

No FM either. This can be nasty. Sometimes VFO's can get some final rf on their grids. The result is a slight amount of FM which shows up as unsymmetrical modulation. That is, the modulation is not the same on each side of the carrier, and maybe the middle is mushy. If you get this condition (you *won't* with *this* rig),you're in for trouble as it is real hard to get rid of, unless you build a new and *different* rig.

So, what more do you want from $1 per watt?

Conclusions

If you build this rig as shown you will get a real feel for a genuine "professional type" transmitter.

Take the time to tune up the various coils and frequencies and you will be rewarded with a rock-stable fully modulated 80 watt VFO rig for two meters. You'll enjoy building and using it.

. . . K1CLL

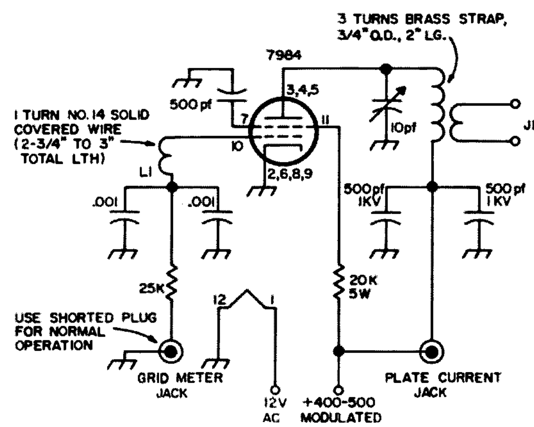
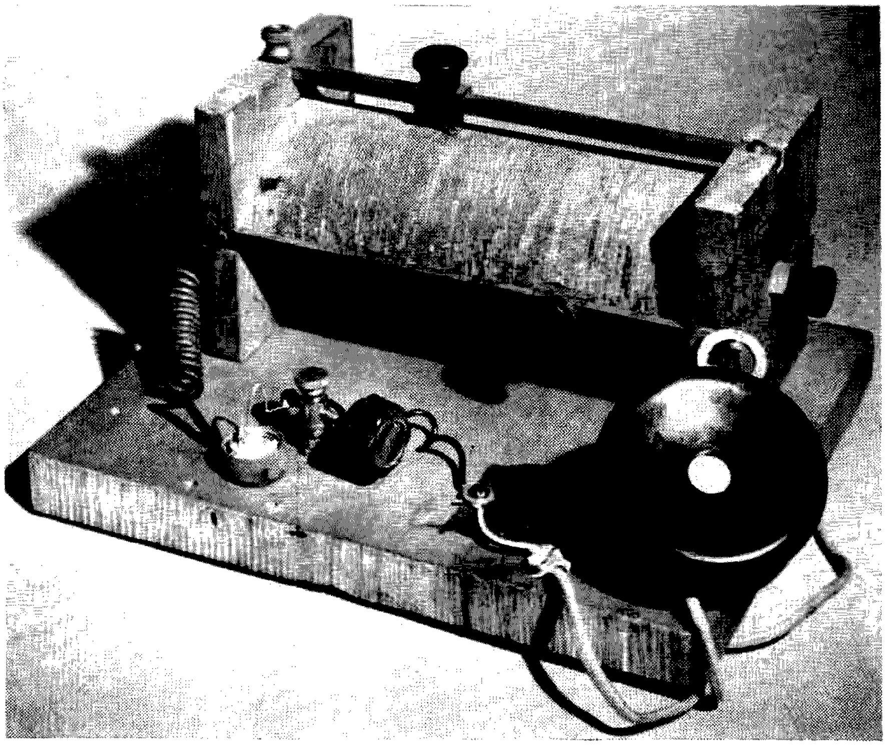


Fig. 6. 80 watt input 7984 final for two meters. See the July 73, page 67, for layout of the final amplifier, which is very similar to the linear shown there.



Yesterday's ham receivers were much simpler than the ones used today. Here's a crystal set that still works well and receives local stations.

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The Novice Class

. . . then and now

Although the amateur Novice license has been established for only a relatively few years, amateur radio has *always* had a novice class even from its' earliest pioneer days. Webster defines a 'novice' as " . . . a person new to a particular activity; a beginner . . .". Obviously, at the turn of the century when "wireless" telegraphy first electrified the world, even the early scientists and operators were little more than 'beginners' in a new art. Newspapers and magazines devoted much space to the new miracle of communication without wires or other connecting medium other than the space around us, then popularly referred to as the ether. Numerous published pictures of wireless telegraph installations seemed to indicate that the equipment required was relatively simple . . . a coil of copper tubing, a few glass jars or plates and a conventional telegraph key formed the nucleus of transmitting equipment. A receiver was even simpler; a spoonful of iron and nickle filings, a pill bottle, a telephone receiver and an electric door bell put the budding 'novice' in wireless telegraphy in business! From there on out it was then, as it is today, simply a matter of experimenting, reading all the related literature he could lay his hands on (it was woefully scarce in early days), sending for the few rather skimpy catalogs then available and drawing on his own initiative and imagination.

In the early 1900's a rather considerable number of lads (and yes, even a few lassies) as well as a more mature class, were seriously experimenting with various electrical devices. A battery of dry cells filched from pioneer garages (outgrowth of the village backsmith shop) where they had been cast aside after short service in the horseless carriages of the day, could be made to produce intriguing results. Bells could be made to ring, buzzers to buzz, both surreptitiously removed from the kitchen wall! Tiny lamps could be made to glow and could be turned on and off at will by switches fashioned from tacks and pieces of tin. Through reptition, these limited experiments were becoming a bit boresome; the embryo Edisons were casting about for broader outlets for their inventive imagina-

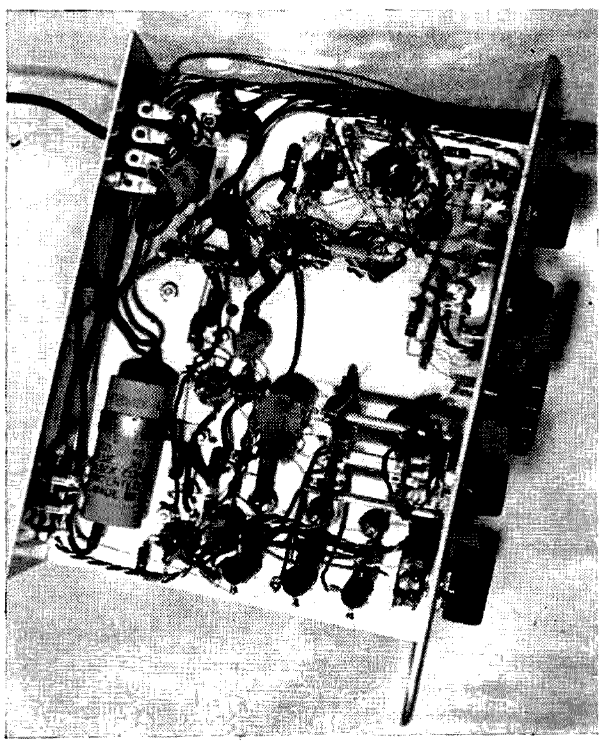
tions. And then came "wireless"; a whole new field with unlimited possibilities! What more natural than that the young devotees of the electrical Genie turn to this new science? And they did . . . literally by the scores! Our first novices were thus born; they knew little and had much to learn. That they *did* learn is overwhelmingly attested by the status of the several hundred thousand members of the amateur fraternity today. They are skilled not only in actual communication but are continuing to contribute awesomely to the development of continually improving apparatus with which to accomplish such communication through space.That is the "then" of the novice, as used in our title . . . . how about the "now" ? Let's see.

The amateur radio novice of today is an acknowledged beginner in a field which offers unlimited opportunity for exciting adventure both in communicating with others of his class and in fabricating relatively simple equipment with which to do so. We use the term "relatively simple" guardedly; by no stretch of the imagination are the transmitters and receivers of the present-day amateur as simple and free of complication as the spark coils from a Model 'T' Ford, a few used glass photographic plates or quart fruit jars and a spool of wire painstakingly wound on an oatmeal box, all forming the nucleus of the pioneer amateur 'wireless' station. International law has long ago ruled out the spark coil and his big brother, the 'spark' transformer. Vacuum tube transmitters sounded the death knell of the crystal receiver . . . the continuous waves generated by tubes are impossible to receive on a 'crystal set'. The one exception is amateur radio telephones; a nearby, relatively powerful amateur radiophone can still be heard using a crystal detector but it is a pretty sorry substitute for a modern vacuum tube receiver; now the tiny 'transistor' is even beginning to replace vacuum tubes in recent ultra-modern amateur equipment!

So, what does the now legally recognized novice class of radio amateur do about it? He has entered the amateur rank of his own volition; he has been attracted to it through acquaintance with one or more others who have entered this charmed land; perhaps he has been a short-wave listener, intrigued by the many and varied conversations he hears on the ham bands . . . possibly he has even been engaged in Citizen's Band communication or has done a bit of playing around with walkie-talkies. Regardless of the magnet which drew him, his interest has been sufficiently fired to warrant his initial attendance at a meeting of the local ham radio club at the invitation of an enthusiastic neighborhood ham.

The fateful evening arrives and they set out to join a motley group assembled in a spacious basement room at the local church. Neat but comfortable clothed are doctors, lawyers, beggarmen and . . . well let's leave thieves out of it, shall we? Nevertheless, all walks of life represented and all age groups . . . teen-agers on up through the more mature and the senior citizens; even perhaps an octogenarian or two . . very likely a few of the charming sex as well! Folding chairs provide generous seating area, a desk up front for the club officers and a table at one side plentifully loaded with a heterogenous assortment of, to our newest novice, a 'wierd' collection of electronic odds and ends; objects for a raffle or auction at the close of the session.

Our novice . . . shall we call him Joe? . . . is casually introduced to several of those present and is almost at once mystified by unfamiliar words lightly bandied about. Yagi . . . 7 meg band . . . ZL's . . . per-selector . . . notch filter ! ! Bewildered at the outset, his confusion continues to mount but at the sound of the gavel Joe finds a seat next to his sponsor, determined to stick it out. The business session of the meeting is conventional . . . this he has been through many times

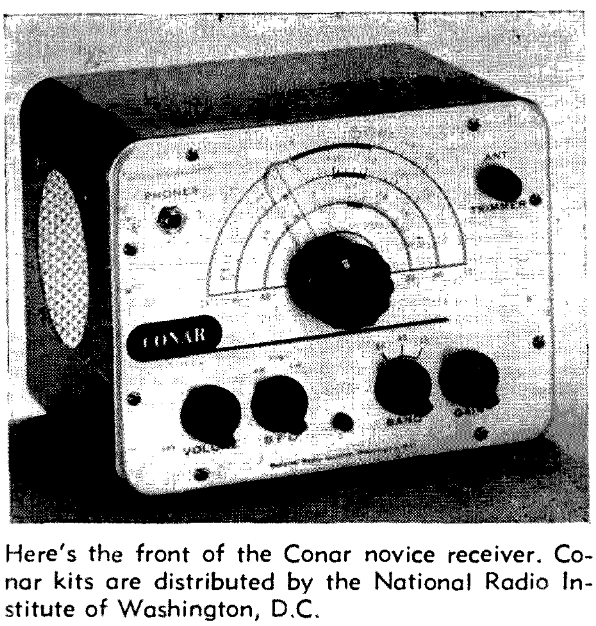


The underside of this modern noice receiver from Conor is far more complex than the crystal set. The complexity pays off in far better performance, of course.

either in school or through membership in other organizations. Finally a rap of the gavel ends the formalities and the president introduces the speaker of the evening. A good talker, he has chosen "Coax Cable vs. Twin Lead" for his subject. It's a good presentation making some valuable points for many but to Joe . . . well this mysterious thing called 'ham radio' looks pretty remote if he is going to have to absorb this kind of stuff!

A welcome respite is next provided with a round of coffee and doughnuts on a self-service table, in exchange for a nickel or a dime dropped in an old shield can serving as a cash box. Then the auction follows; happily the auctioneer has a keen sense of humor and Joe rather enjoys the horse-play although much of the gear which changes hands is totally unfamiliar to him. Disposal of most of the equipment winds up the evening and amid a chorus of "CUL", "73" and similar monkey chatter the gang high-tails it for the home "QTH" and a bit of "DX"! To his pal's query on the way home, "How'd you like it Joe . . . think you still wanna be a ham?" . . Joe replies, "Well, it sounds like it might be fun all right once a guy catches on but all those crazy terms; right now they throw me . . . hey, what does "QSO" mean anyway?" There you have it . . . a ham is born! In the next two weeks until the club meets again, Joe mulls it over . . . maybe thumbs through with a more than casual interest, the few electronic magazines at the local drug store. "It might be fun at that but gee, can I ever learn to talk their language?" he ponders. Conquering the mystifying jargon of hamdom seems to form an almost impossible barrier but it's a safe bet to say that Joe will be on hand for the next and many more club meetings!

Next month we'll start a new series of articles for 73 on the adventures of a new ham as he becomes interested in ham radio, progresses and learns. The series, which will appear monthly, will be written by Howard Pyle W7OE, one of the best known and most prolific of ham radio authors. Be sure to be with us each month!



Here's the front of the Conar novice receiver. Conar kits are distributed by the National Radio Institute of Washington, D.C.

All right, we've taken our embryo ham over the first hurdle; rubbing elbows with kindred souls. The next few weeks only contribute more to his confusion but gradually a few feeble glimmers of light break through the electronic fog. He has even progressed to the point where on meeting one of his club acquaintances, he casually greets him with, "Hi, how's DX?" and leaves with ". . . so long and '73' " . . . definitely Joe is on his way!

The preceding paragraphs are of course, simply a hypothetical exposure to the early stages of a disease known among the fraternity as 'hamitis'. It is the first timid pointing of the feet down the pathway to a glorious and richly rewarding hobby which can, and often does, lead to a profitable lifetime career in electronics as well. The next step of course is serious entry into this mystic realm by acquiring the popular ham magazines, perhaps one of the several handbook familiarly termed the "ham's Bible" and a manual or two dealing with amateur radio construction practice. Catalogs from the numerous electronic mail order houses are sent for and, on arrival, carefully pored through . . . in each reading a little more familiarity with heretofore strange words and phrases is acquired; Joe has his feet wet now and is eager to learn to swim!

I'd like to take you through Joe's subsequent adventures in the marvelous realm of ham radio. His initial efforts to master the code . . . build a simple piece of gear . . . study for his novice examination and eventually pass it. Carry him right on through building his first transmitter and joining the gang in that wonderful world of hamdom. If you'd like to pursue Joe's adventures in the trials and tribulations besetting the newcomer to ham radio, watch for the series starting in next month's 73. We'll lead Joe by the hand through the electronic maze which will eventually put him in line for a shack full of gear and walls plastered with world-wide QSL cards.

Next month: Joe tackles the code.

. . . W7OE

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Tuning the RTTY Signal

Use a simple adapter to simplify tuning RTTY.

If we wish to get the best possible operation from our RTTY gear, it is important that our receiver be correctly tuned to the incoming signal and that the shift on our FSK be correct. This article will discuss the proper tuning procedure for use with audio type RTTY converters and will describe a simple easily-constructed tuning indicator.

Fig. 1 illustrates graphically the proper relations between the receiver tuning and BFO setting that we need for best results. In the correctly tuned illustration, an optimum *if* selectivity curve is shown, with a bandwidth just wide enough to pass the entire FSK spectrum. Obviously, the tuning is most critical for this bandwidth. Note that the BFO should be set 2550 Hz away from the *center* of the *if* passband. It doesn't make any difference whether the BFO is above or below the *if* frequency—this will only swap the MARK and SPACE tones. The incorrectly tuned example shows the BFO set too close to the *if* frequency. Here, the SPACE frequency will "fall off" the edge of the *if* curve causing it to be weaker than the MARK signal. This will result in errors, particularly when noise or fading is present. If your receiver has a wider passband than 1200 cps, the tuning will not be as critical. However, it is very desirable to have the FSK signal *centered* in the passband. We then have the maximum tolerance for drifts, mistuning, etc.

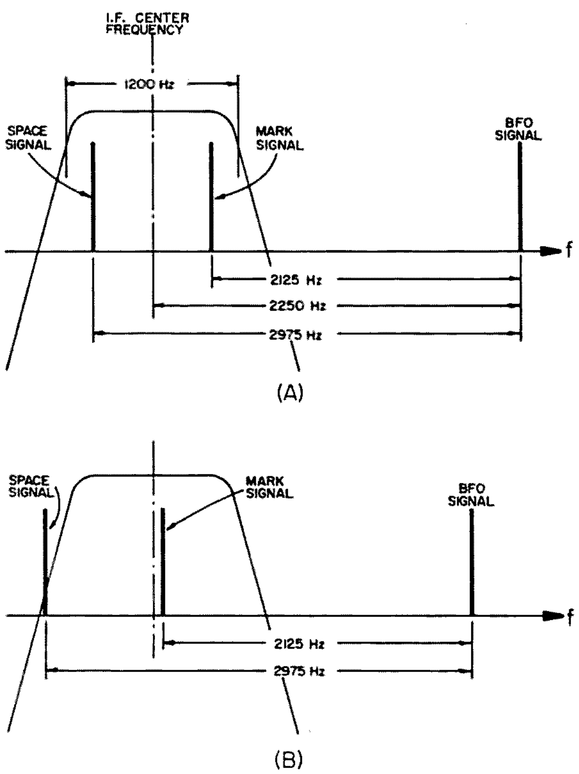

Fig. 1. Tuning of RTTY signals. In A, the RTTY FSK signal is correctly tuned in a receiver with the ideal if passband and the BFO is properly set. In B, the BFO is improperly set with the mark signal in the if passband and the space signal out of it. The distance from the BFO to the if center should be 2550 instead of 2250 Hz.

So we see that we need to do two things. First, get our BFO settings correct and, second, be able to accurately tune in the RTTY signal so that it is in just the right place in the *if* passband. The answer to both these requirements is a good tuning indicator. An additional advantage of a good indicator is that we can set the shift on our transmitter correctly.

Types of indicators

Many different devices have been used for RTTY tuning indicators. A list might include:

- Zero-center meter across discriminator load
- Neon bulbs on keyer output
- Electron-eye tubes on the MARK–SPACE detector output
- Variable-angle scope display
- Flipping-line scope display
- Detected-pulse scope display
- Scope cross-pattern.

Most RTTY'ers have their favorite indicator. However, the display which seems the easiest and fastest for the newcomer to learn to use is the cross-pattern oscilloscope. This method was originated by Merrill Swan W6AEE, one

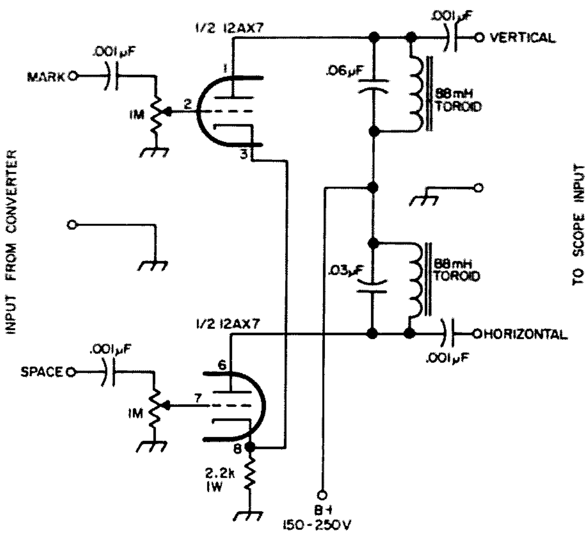

Fig. 2. Circuit of a scope tuning adapter for RTTY.

of the pioneers in ham RTTY. In this type of indicator, a correctly tuned signal with correct shift will produce a perfect cross on the scope face. As you tune through an RTTY signal with the receiver dial, the cross will first be small and will attain its maximum size when the signal is correctly tuned and then will get small again as we detune. If the frequency shift of the received station is incorrect, then one arm of the cross will be shorter than the other. You can experiment with your converter to determine if a signal with the wrong shift prints best when tuned for maximum MARK, maximum SPACE or "in between."

Cross-pattern tuning adapter

Either a standard oscilloscope can be used as a cross-pattern tuning indicator or a scope tube added to the RTTY converter. The simplest way of driving the scope is to feed the horizontal input from one set of the tuned circuits in the converter and the vertical input from the other set. However, most RTTY converters have relatively low-Q circuits for separating the MARK and SPACE tones. The result is that we get crossed ellipses instead of crossed lines as shown in **Fig. 5A.** Accurate tuning is thus more difficult. The solution is to build a simple adapter whose circuit is shown in **Fig. 2.** This adapter can be used with almost any audio-type converter and can drive a standard oscilloscope. It has sufficient gain to drive the deflection plates of a 2" or 3" cathode ray tube directly. The adapter is very simple, consisting of two highly-selective circuits and a dual triode amplifier.

High-Q toroids are tuned to the two audio tones, which are normally 2125 and 2975 Hz These are driven by the two sections of a 12AX7 which has a high plate resistance. The grids of the 12AX7 are fed from the two tuned circuits in the RTTY converter.

It is rather difficult to give exact instructions on connecting the tuning adapter to the many different types of converter circuits in use. The best procedure is to experiment with your particular unit until you find the points which produce the cleanest pattern on the scope indicator. However, we can give some general suggestions. **Fig. 3** shows a block diagram of a typical audio converter consisting of a limiter followed by the audio tone filters. Two amplifiers feed the detectors whose outputs are combined to drive the keyer circuit. Points which may be suitable for connecting the adapter are indicated. Note that the MARK and SPACE adapter inputs are tied together when connecting to the limiter output but are separated when connected beyond the converter filters.

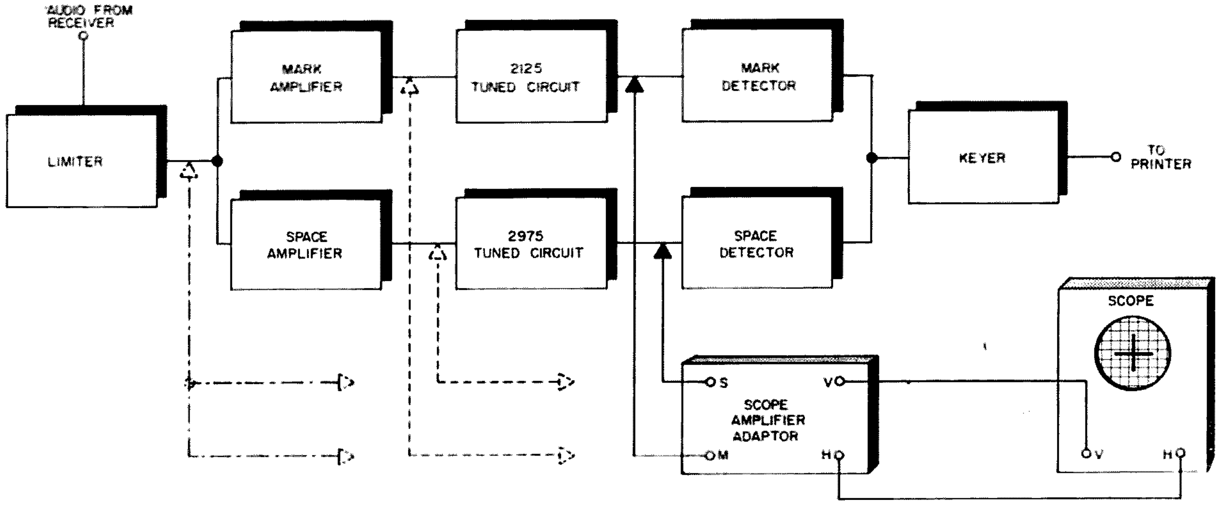

Fig. 3. Possible scope adapter connections for a typical audio-type RTTY converter. Typical scope and scope amplifier adapters are shown in Figs. 2 and 4, but a regular oscilloscope can be used.

Scope indicator

As mentioned earlier, a conventional oscilloscope can be used in conjunction with the cross-pattern adapter as the indicator. However, for a few dollars, a separate scope indicator can be easily built. **Fig. 4** is a basic circuit which uses the power supply in the RTTY converter or other existing supply for the scope high voltage. The scope tube can be a 2AP1 or similar type which are available surplus for two or three dollars. A separate filament transformer should be used since the cathode is several hundred volts above ground. The anode voltage is obtained by deriving a negative voltage from one side of the high voltage transformer in the converter power supply. This voltage will be approximately equal to the peak a-c and may give sufficient brightness depending on the particular scope tube and the transformer in your power supply. If the pattern is not bright enough, then disconnect the ground from the voltage divider network and return to the B+ voltage from the power supply as shown in the dotted lines. This will put the negative supply in series with the positive supply. Be careful not to ground the various pots and use insulated shafts for safety.

No centering controls are shown since most scope tubes will have adequate deflection plate alignment for this use. However, if the pattern is too much off center, it can be corrected by use of a small permanent magnet. The magnet is moved around near the scope tube and taped to the chassis or panel at a spot which gives proper centering.

Aligning the adapter

With the adapter connected to the scope indicator, the two toroids in the adapter can be trimmed to exact frequency. Probably the easiest and cheapest toroids available are the 88mH loading coils which can be bought for less than $1.00 each, although any toroid from 50 to several hundred millihenries is suitable. The approximate values of capacitance required for 88mH are shown. With an accurate source of audio tuned to 2125 Hz and fed to the grid of V_{1a}, the capacitance is trimmed across L_1 to obtain the longest possible line on the scope. Similarly, 2975 Hz is fed to the grid of V_{1b} and the capacitance across L_2 is varied to produce the longest line. Alternately, the capacitances could be fixed and turns removed from the toroids.

After the adapter is properly tuned, it can be connected to the RTTY converter, as described earlier. The scope gain controls are then adjusted for the desired size cross-pattern and the unit is ready to use. Tuning in an RTTY station is extremely simple. Just tune for maximum cross size and that's it! **Fig. 5** shows the patterns obtained for various conditions.

Receiver tuning hints

We mentioned earlier that it is important to have the BFO correctly set. We would like to get our receiver set up so that the BFO is in the proper relationship to the selectivity curve of the *if* as illustrated in **Fig. 1.** Once this is done, we should then tune in RTTY signals using the main tuning dial, leaving the BFO fixed. The following procedure is suggested to get your receiver set in this manner. Once this is done, then tuning RTTY signals with the tuning indicator is easier and faster than CW or SSB!

1. Turn on your VFO to provide a steady carrier.

2. With AGC on and BFO off tune in your VFO signal and carefully peak the signal with the S-meter. You now have the VFO signal centered in your *if* passband.

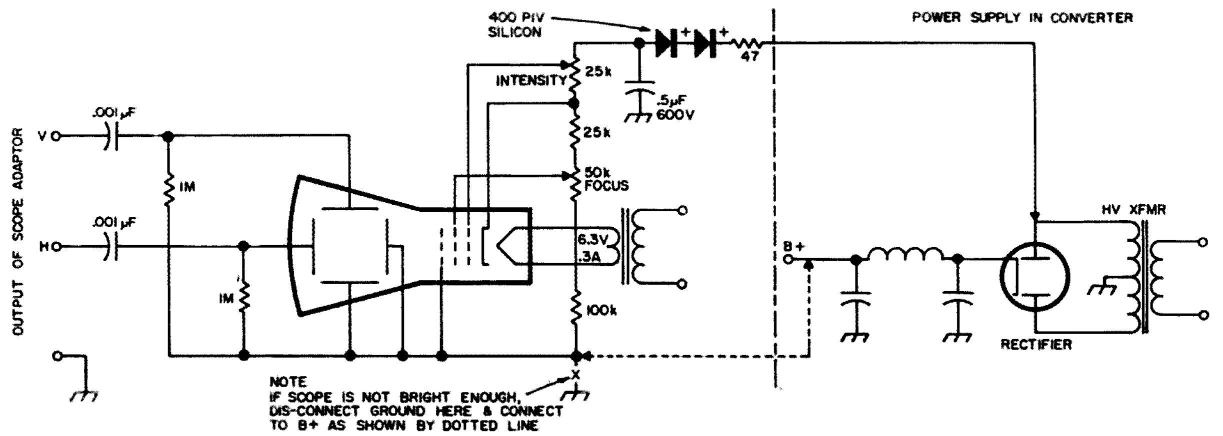

Fig. 4. Simple scope indicator for RTTY tuning unit. A transistorized oscilloscope for this use was described by K8ERV in the June 1966 issue of 73. It can be used as discussed in this article.

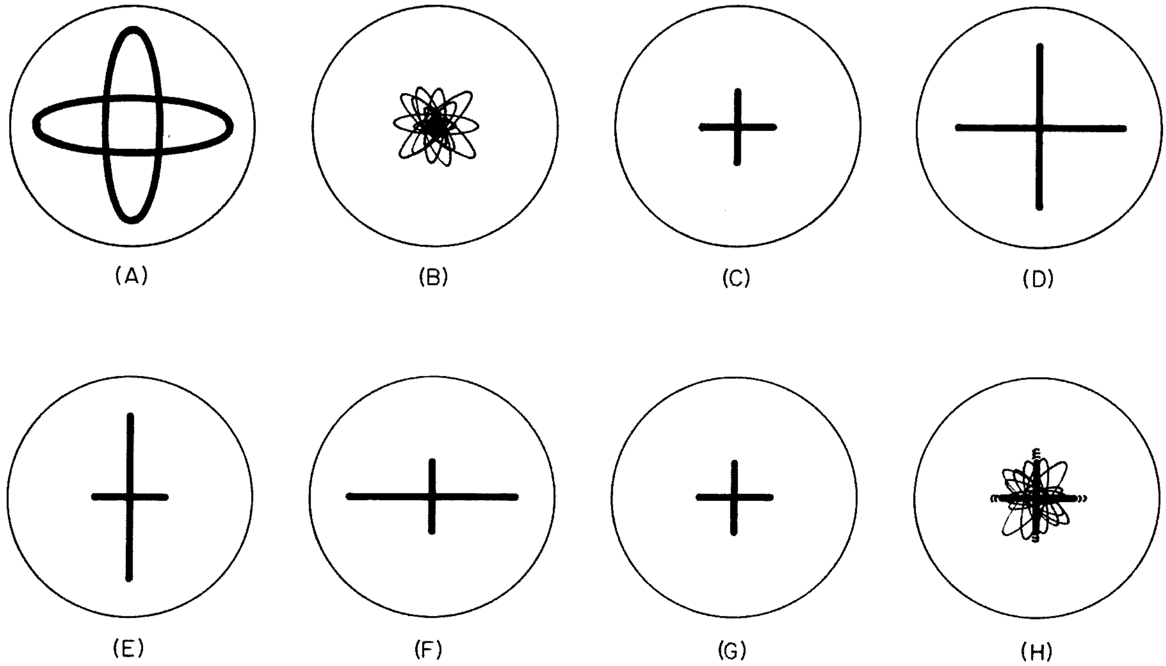

Fig. 5. Examples of RTTY tuning scope patterns for various signal conditions. All patterns except A are obtained using the scope tuning adapter. A Cross pattern from converter using low-Q tuned circuits. B. Pattern with no FSK signal, noise and speech only. C. Correct shift FSK, improperly tuned. D. Correct shift FSK, correctly tuned. E. FSK signal with incorrect shift, peaked on mark. F. FSK signal with incorrect shift, peaked on space. G. narrow shift FSK correctly tuned. H. Weak FSK signal with noise (signal not limiting) correctly tuned. The text discusses the easiest method.

3. Now, turn on the BFO and zero-beat the VFO signal with the BFO pitch control. The BFO is now tuned to the center of the *if* pass-band.

4. Detune your VFO 425 Hz higher in frequency. This will produce a 425 Hz beat note with the BFO. You can set this accurately by operating your FSK (switching between MARK and SPACE) and carefully tuning the VFO so you get the *same* 425 Hz tone from MARK condition as from SPACE condition. This is true since the BFO is in the center, while the space frequency is 425 Hz lower and the mark frequency is 425 Hz higher.

5. Now, retune the BFO pitch control to produce a 2125 Hz beat against one frequency and 2975 Hz beat against the other frequency. This setting can be made most accurately by operating your FSK and adjusting the BFO pitch control for the maximum size cross on the tuning indicator scope. Some BFO controls may not have quite enough range to get the 2975 Hz beat, but this can usually be corected by a slight adjustment of the trimmer on the BFO coil.

6. When the proper BFO setting is found, ake a mark on the receiver panel of some ind so that you can always set the BFO pitch control to this position. *Always* tune in FSK signals with the main tuning dial and not ith the BFO control.

Setting transmitter shift

By using our cross-patterns tuning adapter, our transmitter frequency shift can be quickly set to the correct value. With the transmitter exciter ON and in the MARK condition (keyboard closed), tune in your signal with the receiver until the scope line representing MARK has its maximum length. Then simply depress the break key on the teletype machine and adjust the shift control to obtain the maximum length line on the scope representing SPACE. That's it! Also, zero-beating another RTTY station is very fast and easy with the tuning indicator. When calling another station, you zero-beat his MARK signal by tuning your VFO in the "spotting" mode to produce the same line on the scope. You can also operate your break key for a quick check on your shift.

Conclusions

In order to get the best possible results from his receiving set-up, the RTTY'er should understand how to set his BFO and how to tune in the FSK signal. Some form of tuning indicator is almost essential. The simple-to-use cross-patterns scope type has been a favorite with many and the adapter described provides an ideal pattern. . . . W4EHU

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WWV Receiver for $5

It only takes a few minutes to convert a cheap transistor radio to receive WWV on 2.5 MHz.

Something quite remarkable has happened recently. The combined effects of engineering research and industrial competition have resulted in really workable radio receivers appearing on the consumer market at prices of around five dollars. These inexpensive radios are designed to tune over the broadcast band of 550 to 1600 kHz are battery operated, have a good powdered-iron core antenna coil, and contain five or more working transistors. The circuit is installed in a thermoplastic case of generally attractive design, and comes with a real or simulated leather cover. Discount stores, dime stores, and most of the larger consumer electronics supply houses offer a wide variety of basically similar receivers in this class.

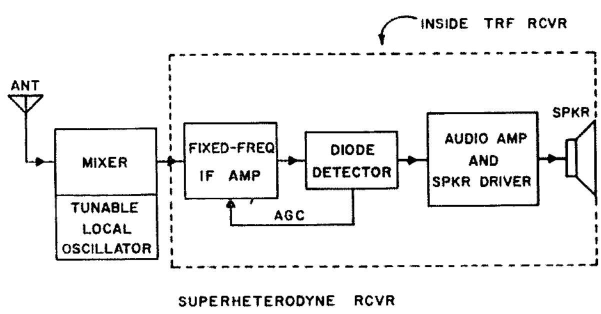


Fig. 1. Block diagram of a typical small superhet receiver without an rf stage. Most five-dollar transistor superhets closely follow this scheme.

These receivers are commonly supplied with a schematic diagram. In a typical model (most of them are about the same; avoid reflex circuits) the first transistor serves as a common-emitter mixer and a collector-feedback tunable local oscillator. The next two transistors are *if* amplifiers at the usual near-455 kHz frequency. There is even an AGC circuit! A diode detector provides the AGC control voltage and the audio to a one-transistor gain stage. A transformer-coupled two transistor push-pull audio output stage, which may include a thermistor for compensation of temperature effects, feeds the small loudspeaker. A small phone jack may be wired to disconnect the loudspeaker when using the low-impedance earphone. The usual arrangement is shown in block-diagram form in **Fig. 1.**

At the low price of $5.00, a receiver should be satisfactory if it works at all! Observation is more encouraging than that: most of these receivers are considerably better than 'usable'. And they commonly show distinct indications of good engineering, such as electrical stability, and a clean, relatively open layout. Maintenance is not difficult and replacement parts or substitutes are easily obtained. Their style of construction, although well under MIL specs, is far from flimsy. Most of these receivers are not toys: they are real, usable electronic devices.

But what are they good for? How their

manufacturers must gnash their teeth over the usual broadcast fare! It neither informs nor impels to action; white noise is more pleasing and useful. Some other application must be found for one of these attractive devices. A few ideas have appeared in ham magazines from time to time: a fix-tuned *if* for a VHF receiver, or a conversion to a simple service instrument. A recent QST article suggests stripping out most of the circuit to build up something almost entirely different. Such drastic revision is not proposed here. It's a remarkably simple job to convert one of these receivers to a usable WWV receiver.

A little history

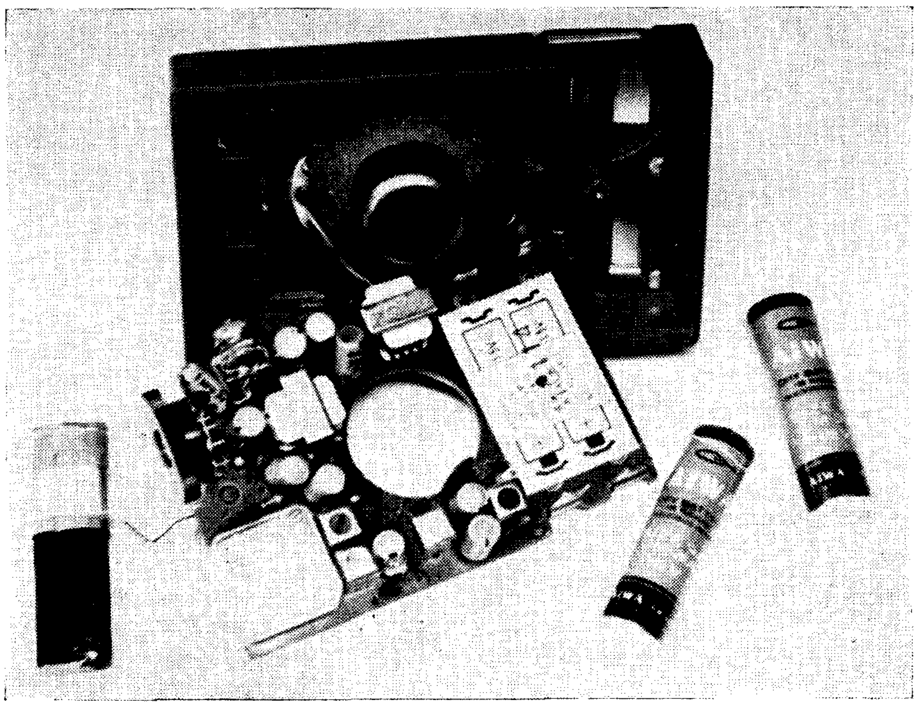
Almost any radio receiving system contains an amplifier of some kind. Only the simplest ones do not: the crystal receivers built in the early days of radio, and still built for some purposes, utilize only the incoming energy from the antenna. These receivers are insensitive and no longer serve for normal communications work.

The history of radio is largely the story of years of research upon a very central problem: how can a smaller signal be made to yield a usable result? And the smallest usable signal has become very small indeed. Imagine a 1-watt lamp and its general illumination of the surrounding territory. This represents roughly what Hertz had achieved by 1889. Nowadays a millionth part of this 1-watt illumination, or 10^{-6} watts, is regarded as a huge signal which is likely to overload the receiver. A further reduction by another million times brings the signal to a workable level, about 10^{-12} watts. Most amateurs would regard a signal as fairly weak at another hundred times smaller: 10^{-14} watts, or about 0.7 microvolts across 50 ohms.

What did the old-timers do about small signals? At first they had to get along with no amplifiers at all. Hertz's spark gap soon yielded to improved detectors such as the coherer and later the electrolytic, the crystal, and some other varieties. There was great emphasis on making the most effective use of the signal. Much of the early literature is devoted to better coupling devices, and there were even such things as push-pull crystal receivers. Later arrangements used primitive thermionic triodes as RF amplifiers at the received frequency, and these developed into the TRF or Tuned Radio Frequency receivers which have lasted almost up to the present.

Something really new happened in 1918. Edwin Armstrong, then in Paris as an officer in the Signal Corps, built a strikingly improved kind of radio receiver. A year and a half later, in 1920, he received his patent on one of the most popular circuit ideas in history: the superheterodyne circuit.

He used an amplifying and detecting system that always operated at the same frequency. The designer, engineer, and builder could exert their full skill and knowledge against the problem of making something uncompromisingly intended to do the best possible job. Troublesome tuning, tracking, and feedback difficulties were greatly eased by this simplification. Then he made his fix-tuned receiver respond to frequencies other than its own by adding a converter circuit: any given frequency fed into the converter could be made



The WWV receiver just before assembling back into its case. The antenna leads are very fragile!

to come out as the right frequency for the fix-tuned receiver. The converter could be designed to feed any frequency within a wide range into the fix-tuned receiver. This was the basic principle that has become one of the key ideas of radio electronics.

His converter circuit is now called the mixer, and it is often arranged to perform a second function as a local oscillator. It's easy to forget that the *if* amplifier is really a complete receiver in itself: a TRF receiver often fix-tuned to about 455 kHz. This basically simple and highly workable idea (the number built so far must be in the tens of millions!) does have some peculiarities, or depending on your point of view, a few shortcomings. This simple conversion of a tunable broadcast to a fix-tuned shortwave receiver depends on one of them.

Superheterodyne operation

About 1800, a French mathematician was working on a difficult problem. He was trying to develop a mathematical description of the actual events occurring when a stretched cord is pulled away from its resting position and abruptly released. He solved his problem in a way that some mathematicians of his day refused to accept as mathematics. His name was Fourier; many modern eletronics handbooks have tables and collections of equations based on his results.

The question of how a superheterodyne mixer works can be studied by Fourier analysis. The engineer writes down a simple equation to represent the two frequencies applied to the mixer input, and then he writes a longer, rather hairy looking thing to represent the output. He writes a Fourier series. Then he may red-pencil a circle around one or two of the terms and simply ignore the rest. The two important terms are (1) a frequency equal to the numerical sum of the two input frequencies and (2) a frequency equal to the numerical difference between the two input frequencies. The sum frequency is interesting to transmitter builders, and is the basis of Hoisington's one-tube 50MHz. VFO described in the June 1966 issue of 73. The difference frequency interests us and receiver builders in general. And the terms ignored aren't really gone; they come back sometimes to produce unwanted birdies. Fisk's article in the April 1966 issue of 73 discusses that problem.

The little superhet we are about to modify probably has an *if* frequency of 455 kHz. This means that its inside TRF receiver (see **Fig. 1** again) is responding to the difference between the input frequency and an oscillator frequency which must be either 455 kHz higher or 455 kHz lower than that input frequency. The manufacturer practically always chooses an oscillator frequency above the received frequency in these little receivers; it simplifies necessary adjustments.

Let us suppose the receiver is tuned to 1590 kHz. This is still within the broadcast band, but very near its upper edge. Its local oscillator must be operating 455 kHz higher, at 2045 kHz. Adding 455 kHz to this known oscillator frequency, we come to 2.5 MHz as the other value which differs by the *if* frequency from the oscillator frequency. If we can make a small revision in the input circuit to emphasize the 2.5 MHz, we will have a WWV receiver!

The conversion

The appropriate instruments for this conversion are a grid dip oscillator and an RF signal generator. It is not a difficult conversion and with care you may be successful without the instruments. In either case, try to find a short-wave receiver capable of picking up WWV before going ahead. Sometimes it sounds quite weird. The one-per-second ticks are distinctive, and there is a time announcement each five minutes.

Check the receiver for normal operation before starting the conversion. If it is working properly, tune to just under 1600 kHz, remove the battery, and dismantle the circuit board from the case without disturbing the tuning capacitor. Remove the knob from the capacitor, and fill in the remaining hole in the case with a piece of cardboard. A coat of clear fingernail polish will improve the cardboard, and it may be held in place with some glue or epoxy cement.

Free the loop antenna structure from the printed circuit board, but do not disconnect any wires. Be gentle! And then trace backwards from the mixer transistor to the link coupling from the loop antenna. This circuit must be opened since the grid dip oscillator may be powerful enough to destroy the mixer transistor. The base circuit is best opened at the end opposite ground: the connection to the mixer base terminal. Don't worry about possible detuning.

Use the grid dip oscillator to find the resonant frequency of the antenna coil. It should be very near 1590 kHz, because it was set to that value before dismantling and events should not have disturbed it. If it is not near this frequency, you must find out why! Perhaps the oscillator frequency is off also, making eventual success very hard to achieve.

When the antenna coil dips at the right frequency, and perhaps after checking the

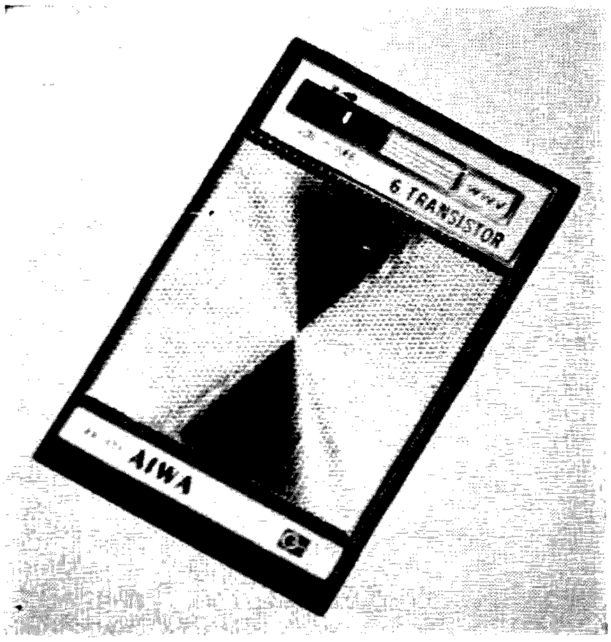
oscillator frequency at 2.045 MHz, start taking turns off the antenna coil. Do not adjust the capacitor! Remove a few turns of wire and check the resonant frequency. Take off another few turns and dip again. Try to come up on the required 2.5 MHz by easy degrees so that you certainly do not overshoot.

After the antenna coil is modified to dip at 2.5 MHz, take a few turns off the link coupling to the mixer. The antenna coil and the link should be reduced by the same percentage: it should have worked out to a little over 30% reduction. Then remake the open mixer base terminal connection, and remount the receiver in its case. The modification is complete; only adjustment remains.

Warm up the signal generator, set it to internal modulation, and bring an unshielded lead from its output near the receiver. If its output is too strong, the following does not work very well; distance or a weaker signal is indicated. Tune the generator around the vicinity of 2.5 MHz to find what frequency the receiver is responding to. Having found it, retune the generator slightly nearer the desired 2.5 MHz but not quite out of the receiver passband. There are two tiny trimmers in the tuning capacitor; a small adjustment to one of these will center the receiver on the generator frequency. Readjust the generator still closer to 2.5 MHz and trim the receiver to frequency again. The little trimmers are capable of a surprisingly wide range of adjustment; it should not be necessary to adjust the main capacitor. Continue until the receiver is zeroed on the signal generator's 2.5 MHz.

The other trimmer is now known to be the antenna coil trimmer. Adjust it for maximum response to the generator signal. This nearly completes the job; only an on-the-air test is required. Early morning or evening is the best time for this, when signal propagation conditions are good but not so terrific the receiver's broad selectivity is overwhelmed by powerful transmitters adiacent to WWV. An external antenna should not be needed in central USA. If required, it can be coupled to the receiver by two or three turns of wire, large enough to slip the receiver inside.

Shortwave transmitters should be quite audible. Tune the oscillator trimmer up and down from its starting setting (check its position before making adjustments). When you have located WWV, peak it up with the antenna trimmer, and then zero in for strongest reception by adjusting the *if* slugs. No harm in this! Fixing the antenna and oscillator circuits to a single frequency has eliminated the strict conditions that must be met for correct



This receiver is fix-tuned to WWV at 2.5 MHz. Two small pieces of cardboard fill in the holes left by removal of the tuning dial.

tracking; you can now tune the *if* to any frequency you like. Vernier tuning in this way is very easy. When the receiver is zeroed in, the job is done. Replace the receiver's back—and it'll last for years.

Loose ends

As they are used in *if* circuits, transistors tend to cause regeneration. A close look at the schematic may show a tiny capacitor from the end of the tuned *if* winding opposite the collector connection right back to the base of the transistor. This capacitor feeds a small signal into the base circuit opposing the signal which leaks back through the transistor. If this capacitor is removed, the receiver may not quite go into oscillation. A very perceptible improvement in sensitivity results. Don't wreck the capacitor, you may want to put it back.

In some regions an external antenna may be required at any time to hear WWV. Sorry, I do not know how sensitive this receiver really is. If you are far from the transmitter, located in Greenbelt, Maryland and moving to Colorado, a more elaborate conversion to a large external loop may be in order.

I purchased a pair of these receivers. I haven't converted the other one yet; maybe it will make a good first and second *if* for an inexpensive tuner following a VHF converter. This should require one or two additional transistors, so that perhaps the tuner could be completed for $10 to $20. Look for this in a future article.

. . . W2DXH

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Streamlined Modulators for Transistor Transmitters

Presented here are two unusual methods of modulating transistor transmitters that rival the commonly used transformer coupled collector modulation technique in performance. While neither circuit is really new (they both have basic vacuum tube histories), the implementation to transistor circuitry is unique. Both of the techniques discussed streamline the modulator by eliminating the bulky modulation transformer and its attendant matching problems. Hence, the primary advantages of reduced size, weight, and power consumption gain by utilizing transistors are further enhanced by streamlining the modulation amplifier.

DC-series modulation

The compact, high quality modulation technique shown in **Fig. 1**, is termed dc-series modulation because the modulating transistor is in series with the final dc supply voltage. In this circuit, the modulating transistor is shown in the emitter leg; however, it is effectively varying the collector supply voltage. The emitter is used because proper voltage polarities are available for coupling the low cost pnp germanium audio transistor to the NPN silicon rf power device.

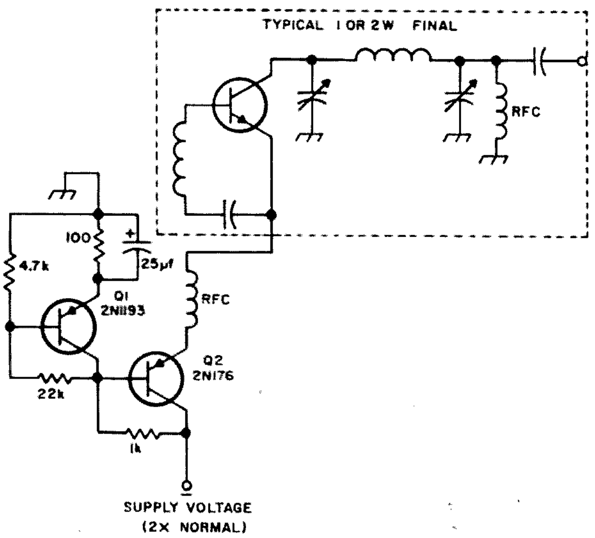


Fig. 1. DC series modulation of a transistor amplifier.

The components shown in **Fig. 1**, and, in particular the 2N176 power transistor, are intended for use with a low-power (1 or 2-watt) final; however, a power transistor with a higher current handling capability could be used in place of the 2N176 to modulate higher power transmitters. In which case, select a transistor with a high current gain so that it can be easily driven by the audio driver transistor.

The circuit works somewhat like a controlled carrier circuit. With no audio drive, the 2N176 modulating transistor is biased to furnish about ½ of the supply voltage to the modulated stage. Then, audio peaks drive Q2 to full conduction furnishing the entire supply voltage to the final. Likewise, the audio valleys cutoff Q2 reducing the voltage to the final to zero. Hence, the carrier power output is being controlled by the modulating signal and is varied at an audio rate.

There is one minor disadvantage of this modulation technique. As indicated on **Fig. 1**, twice the normal supply voltage is needed. The reason for this comes to light, when the standard transformer coupled collector modulation circuit is examined. Here, the audio peak-to-peak voltage supplied by the modulation transformer effectively changes the instantaneous collector voltage from zero to twice the supply voltage at 100% modulation. However, in **Fig. 1**, the modulator is not supplying any additional audio voltage, it is only controlling the supply voltage. Therefore, to get the necessary voltage swing, the supply voltage must be double that normally used for transformer coupled collector modulation. Like transformer coupled collector modulation, the dc-series modulating technique is also plagued with driver feedthrough. That is, due to capacitance effects, the drive signal feeds through on downward modulation; hence, preventing full down modulation. Thus, it is difficult to obtain 100% modulation unless the driver is also modulated.

The audio driver Q_1 is a conventional common emitter amplifier that provides about 20 dB of gain. Approximately 0.14 volt applied to

the base of Q_1 gives full modulation. This drive can be obtained from one or two stages of common emitter amplification depending upon the microphone used. Q_1 can be almost any type of good quality pnp transistor.

Performance wise, the dc-series technique is superior to the conventional method since it yields a greater modulated power output, lower distortion, and overall transmitter current is lower. Moreover, in a comparison test a larger detected audio voltage was achieved (with a diode demodulator) from the dc-series modulated transmitter than from the same final when it was transformer coupled collector modulated. This is an important criteria considering that what really counts, in an AM system, is the detected audio.

RC-coupled base modulation

A second circuit, RC-coupled base modulation, shown in **Fig. 2,** also has performance capabilities that are competitive with the usual collector modulation technique.

In this circuit, the modulation is injected to the base of the RF transistor using two resistors, R1 and R2. The effect of R1 is to linearize the waveform which is excellent for values of R1 between 10 and 20 ohms. Negligible improvement in linearity is achieved for larger values of R1. Also, R1 should not be bypassed for audio because bypassing introduces negative current feedback in the final RF stage at audio frequencies. Resistor R2 can range between 100 and 2,000 ohms. Ultimately, the upper value of both R1 and R2 is determined by the available rf drive power because greater drive power is needed for larger values of resistance.

The effective load resistance, presented to Q_1, is essentially equal to R2. Therefore, to reduce modulation power requirements it is desirable to make R2 large. Thus, with these conflicting requirements some type of a compromise is necessary. Hence, the values given in **Fig. 2** represent a good compromise between linearity, rf drive power and modulation power requirements.

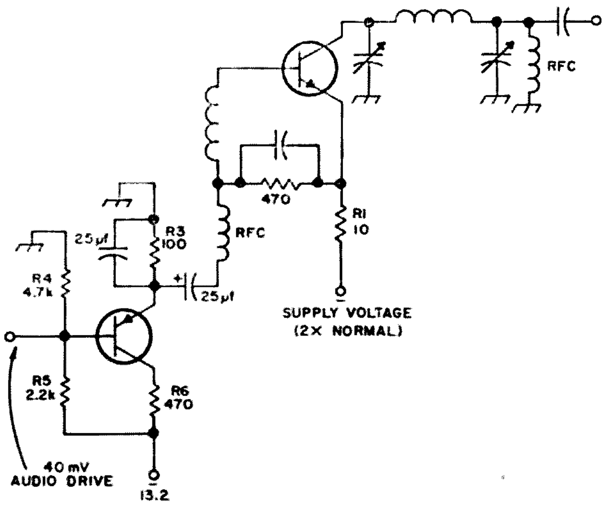


Fig. 2. RC coupled base modulation.

This rc-coupled base circuit yields excellent modulation characteristics because it has built-in feedback, and, it also prevents feedthrough which in turn permits 100% modulation to be easily achieved. A disadvantage is the higher power dissipation in the rf stage due to the extra drive discussed previously. Therefore, you may want to add a little additional heat sinking to take care of the additional power dissipation.

The audio stage Q_1 uses a small-signal, general purpose audio transistor in a common emitter stage. From the circuit components shown, an undistorted output of about 2 volts can be supplied to the base of the final with 40 mV of audio drive signal. This is sufficient to provide 100% modulation for a transmitter in the 1 to 2 watt range. For higher power finals, an audio stage capable of supplying a greater voltage swing should be used. Since the audio signal is being applied to the base of the rf stage, it functions as a common emitter amplifier for both the RF and audio.

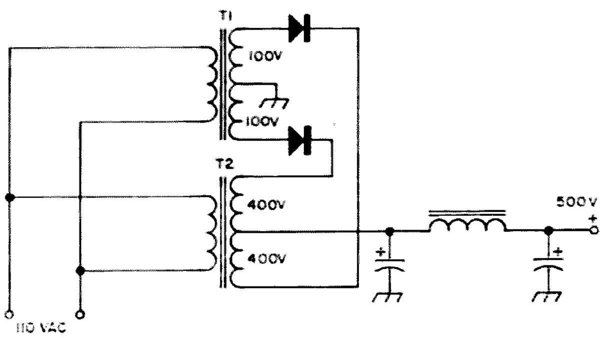
Why not try dc-series modulation or rc-coupled base modulation next time—they both perform well and do away with the bulky, expensive transformer that is difficult to match.

. . . Thorpe

Unlike CT Transformers

Usually unlike power transformers cannot be connected in series to obtain higher dc output voltages because no center tap is then available. This circuit illustrates a method of accomplishing this. The transformer on the positive side must have sufficient insulation to withstand the combined voltages. The primaries of course must be correctly polarized—if little or no output is obtained reverse the connections to either primary.

. . . Robert Kuhn WØHKF



Larry Will K3ADS
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Bryn Mawr, Pa.

Amateur Television— Let's Get Started: Part II

This article continues on with an introduction to setting up your ham TV station. It covers transmitters, modulators and antennas.

Now that the camera and receiving gear are working, it is necessary to assemble some sort of transmitter. While it is possible to use television on any amateur band above 420 MHz, as a practical matter most transmissions are in the 420 band. The 420 band provides the greatest coverage per watt and enables those already on the band with CW and phone equipment to utilize this equipment.

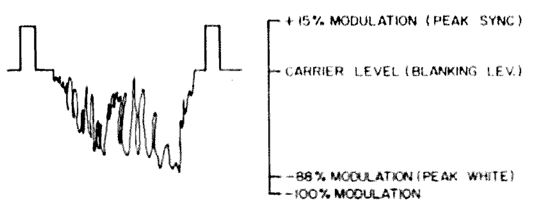

Fig. 1. Video modulation. Note that the sync modulates positive 15% while the video modulates negative to 88%.

The band is divided per a gentleman's agreement:

420-432 MHz	wideband audio stable
432-436 MHz	CW and audio
436-450 MHz	television

Thus the TV minded amateur has 14 MHz to use up.

The television modulator

In order to put the wideband TV signal on the carrier, a video modulator is necessary. The commercial standard is to use a bandwidth of 4.2 MHz for the picture information. This equals a horizontal resolution of about

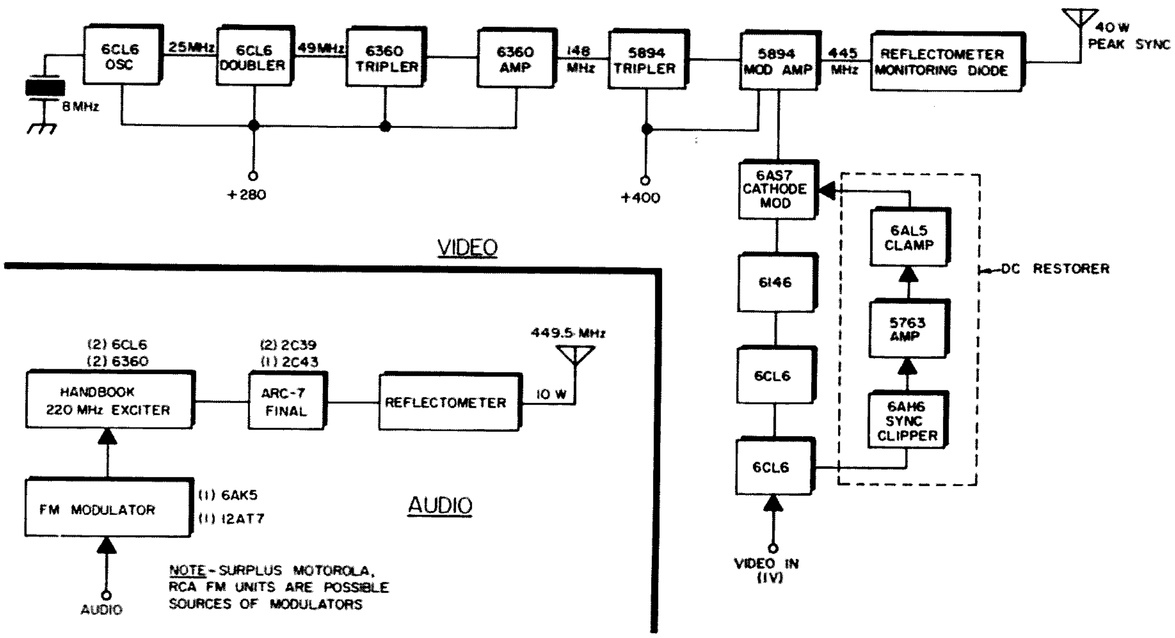

Fig. 2. Block diagram of the television transmitter used at K3ADS.

336 lines. This is an excellent picture capable of very fine detail. The average TV receiver, considering ghosting and other problems, normally will give a 250 line picture with a 200 line picture being entirely satisfactory.

Therefore to obtain a 200 line picture, the video amplifiers and modulator must have a bandwidth of at least 2.5 MHz. As a practical matter, a 2.5 MHz bandwidth is really easy to obtain. This wide bandwidth, however, results in amplifiers with low gain so several stages of video amplification are necessary. One of the most popular surplus modulators is the CRV series, originally used in a 250 MHz TV transmitter. This can be used to grid modulate tubes such as 5894 or 6939.

Most modulators for TV use grid or a combination of grid and cathode modulation. In AM work, this would be a poor modulating scheme, but in TV the modulation is essentially negative as per **Fig. 1** and therefore even though grid modulation is used, the tubes may be run at full CW inputs. Notice that sync modulates positive about 15% and that video modulates negative about 88%. More on this depth of modulation later. When using cathode modulation, the cathode must be grounded well for rf but not for video. Use good button bypasses of 10-40 pF.

The rf exciter

Fig. 2 shows a block diagram of the K3ADS television exciter. Two things are evident. First, the transmitter is a combination of units that have appeared in print. The low level exciters are the 220 units appearing in the older editions of the ARRL Handbook.[1] The visual exciter was moved to 144 MHz. In the visual transmitter, the last 6360 drives a surplus[2] Link 450 MHz FM final.

The other feature of this transmitter is the inclusion of an FM sound transmitter 4.5 MHz above the picture carrier. By sending audio along with video, the receiving station copies the entire signal directly on the TV set. Because of the narrow bandwidth of the audio channel, a power of only about 10 or 20 per cent of the visual power is needed, and the second 220 exciter drives an old surplus ARC 27 final to about 10 watts output.[3]

The video modulator used at K3ADS is a convertered commercial unit and due to the inavailability of many of the parts, I will not

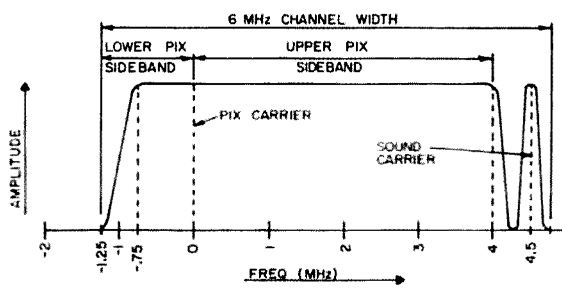

Fig. 3. Ideal TV transmission characteristics.

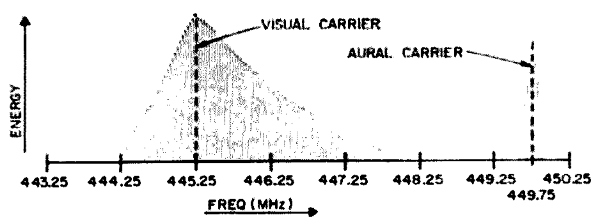

Fig. 4. Panoramic spectrum of complete TV signal.

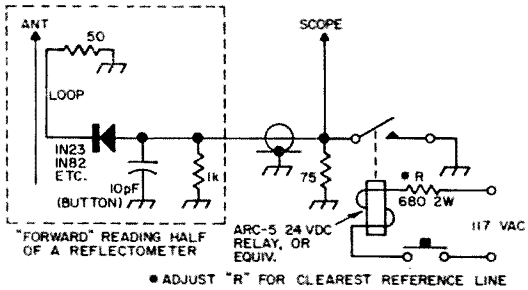

Fig. 5. Method of monitoring TV modulation.

describe that particular circuit. Instead, I refer you to previous articles.[4]

The modulated amplifier

Most of us look at tubes like the 5894, 4X250B, etc., and marvel at the low drive requirements. We fail to look closely at the fine print in the tube manual that says 'at frequencies above 175 MHz.' Looking there, one finds that the 5894 takes 13 watts of drive, and the 4X250B, 18 watts, at 500 MHz. In order to meet these requirements, the final amplifier should be driven by a tube of the same type. For example, do not try to drive a 4X250B with a 2C39A. The latter just doesn't have enough steam. As a rule of thumb, the driver stage should have a power *output* of *twice* the power drive requirements of the final to account for circuit losses. Be sure the tube operates properly as a CW amplifier before attempting to apply video. An rf wattmeter is useful here.

Bandwidth and vestigal sideband transmission

The AM modulation of the final with a video signal of 2.5 MHz bandwidth would result in an rf signal 5 MHz wide. In order to conserve spectrum, vestigal sideband transmission is used which attenuates the lower sideband according to **Fig. 4.** The filter necessary to do this is complicated and fortunately the amateur can accomplish the same end by tuning the transmitter on the high frequency side of carrier resonance. This will accentuate the upper and attenuate the lower sideband and actually will improve the received picture since the TV receiver uses mainly the upper sideband. In addition, the input and output links should be overcoupled to lower circuit Q and improve bandwidth. All these procedures reduce efficiency of the final amplifier. This is the price for high quality pictures. Use a big blower!

The complete television signal with audio would look something like **Fig. 4** on a panoramic receiver. Notice that the signal takes about 5.5 MHz with a small 'hole' below the sound carrier.

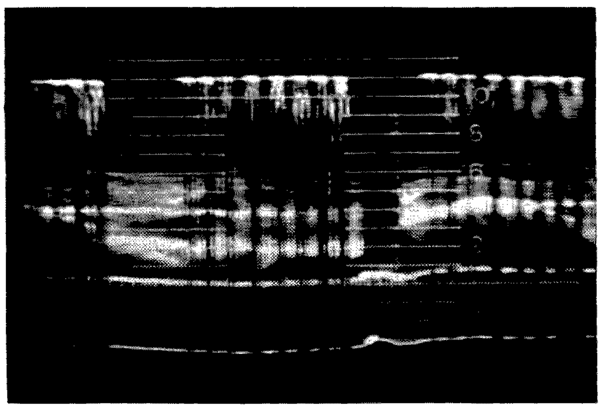
Fig. 6. Modulation monitoring. The white line at plus 112 IRE (IEEE) units is the chopper reference. On this picture, the percent of modulation is difficult to see. In use, the pattern is normally clearer than shown here.

Modulation monitoring

Fig. 5 shows a video 'chopper,' the gadget used to measure modulation. It is simply a DC relay connected through a pushbutton to an ac source. The contacts alternately close and open across the video from a sampling diode producing a jagged line on a scope at 112 IRE* units as in **Fig. 6.** This line corresponds to 100% negative modulation. The positive modulation is of no problem as the transmitter only goes to plus 15%. The problem usually is overmodulation negatively as in **Fig. 8.** Note the clipped whites. On the screen, these clipped whites appear as indistinct bright areas, exactly as is the case when the beam control is too low on the camera.

The procedure in adjustment of the modulated amplifier is to adjust the video level, dc bias, value of the grid resistor, and drive to the final to obtain a trace similar to **Figs. 6 and 7.** A compromise must be reached between power and video. Too much power to the final (too little bias) results in overmodulation and distorted sync. Too little power input results in

*Actually, IEEE units, now, of course.

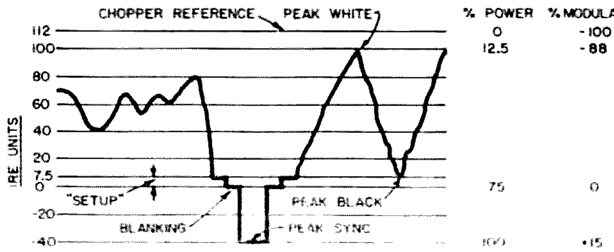

Fig. 7. Drawing of the TV signal and the chopper reference. IRE units are on the left while percent modulation and percent of power are shown on the right. In TV transmitters, power is referred to peak sync, not carrier level.

low modulation and a pale 'washed out' picture.

Problems

In the tuneup procedure, the scope should be moved alternately from the modulator plate to the monitoring diode. (**Fig. 5**) The video waveform should be identical at these two points. If the video at the modulator plate is not like **Fig. 7** (less chopper reference), the modulator should be checked for the same problems described under camera adjustment last month. If all is in order on the modulator, but the monitoring diode shows distortion such as clipped whites or loss of sync,) the power amplifier operating controls must be readjusted to obtain a good scope presentation.

One of the problems occurring in the amplifier is the loss of sync. This can be caused by low drive or too low a fixed bias on the amplifier. If bias is near zero, the video will invert and sync will go 'negative.' This condition is characterized by a violently jittering picture with white sync bars as opposed to the customary black when viewed on the picture monitor.

The most important trouble is clipped whites as in **Fig. 8.** We all have a tendency to overmodulate. I emphasize the need to limit negative video to −88 per cent. The teletail clue is the waveform of **Fig. 8** as seen at the monitoring diode.

rf in the shack

Some cameras are sensitive to 440 MHz energy. Rf feedback into the video amplifiers is possible at any stage but usually finds itself in the low level video amplifiers in the camera. It is characterized by a change in the picture as seen on the direct (not the off-the-air) monitor when the video level is brought up on the modulator. The picture can be completely wiped out if the feedback is great enough. The solution is to locate the camera away from the transmitter or to remove video amplifiers one by one starting at the preamp to isolate the defective stage. Small (10 pF or less) capacitors on the grid and plate of the culprit stage should remove the interference. An rf sniffer should be constructed to find hot leads. **Fig. 9** shows the one used at K3ADS. It is amazing how many leads that are not supposed to have rf, actually do. Adjust the pot till the bulb just lights when away from rf. When the bulb is placed near a source of rf it will become brighter usually turning purple instead of orange. Install filter networks of small 432 rf chokes and 100 pF capacitors on power leads showing rf. On coax cables between units, the match should be adjusted for minimum SWR between the units. The line between the driver and the PA is especially vulnerable.

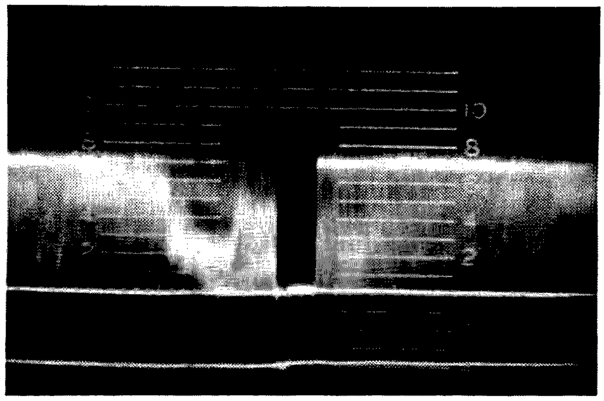

Fig. 8. Clipped whites. Note the bright line at plus 70 IRE units. All whites are the same brightness here, a condition that normally doesn't exist in a picture.

Antenna systems.

All that need be said is that all the rules for UHF antennas apply doubly for TV. Build 'em big and high. For a good TV picture, an S9 signal is needed. Most important is the match. A high SWR results in reflections that produce ghosts on the picture which cannot be eliminated at the receiving end. A UHF SWR bridge is a must.

Conclusion

I hope these articles will encourage those who have started a TV system to dig it out and get it working. Perhaps a few newcomers might get started. To paraphrase a familiar statement, "Come on down . . . to three quarter meters, there's lots of fun a waitin'." I wish to thank Larry, K3MKK, and Barry Cruise and Ross Kauffman, W3ZKU, for photographic help of these articles. . . . K3ADS

1. Exciter-Transmitter for 220 Mc.; 1958 ARRL Handbook p. 432.
2. Available from "Selectronics" Philadelphia, Pennsylvania.
3. W5AJF, Putting the ARC-27 on 432. December 1963, 73.
4. W8VCO, Video Modulator. October 1963, 73.

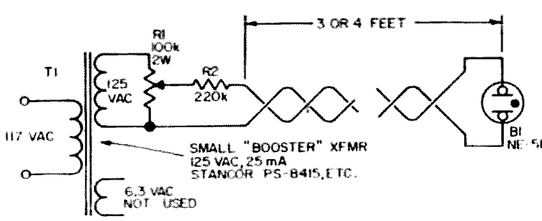

Fig. 9. Rf sniffer for cooling down a transmitter assembly. Shield the sniffer and be sure to insulate the bulb from high voltage.

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Some Thoughts on Designing High-Voltage Power Supplies

K6ZGQ takes a different approach to a power supply for an SSB transceiver.

A few months ago a new transmitter of commercial manufacture was acquired at K6ZGQ. This was a high quality unit, but came without a power supply, as do many medium-power transmitters today. As a consequence, the first order of business was to build up a source of the various voltages required for the rig.

The first thought was to build a power supply like most of those being used today; that is, pack all the power capability possible into a very small size, using every trick to reduce the size, weight and cost. After all, that seemed to be the newest trend in transmitter power supply design today, so why not follow the herd? But the writer being a conservative chap, it was decided to pursue a different line of design philosophy.

A few years ago most transmitter power supplies were heavy, bulky things. This meant that if you were a kilowatt class operator, you hired a separate truck for the power supplies when moving day came around. But those supplies did have one big advantage; they were much more reliable than the featherweight types seen doing the same jobs today. As a result, most users of this type supply didn't have to worry about an essential component going west just at the minute a rare DX station was finally snagged through a big pileup on 20. Further, the problem of replacing transformers, chokes and filter capacitors had to be coped with a lot less often. And a conservatively designed supply is a lot more forgiving of design errors than is the smaller variety.

So it came about that the author's 200-watt transmitter acquired a 100-pound monster for a power supply. To be fair, the expense, using surplus components from the pages of this magazine, was about twice what could have been accomplished using lightweight techniques. But this supply will still be operating long after a smaller supply would have been repaired, or even rebuilt, several times. And after all, why put a 20 dollar power supply on a transmitter that cost several hundred dollars?

This is really an idea article, not a construction piece. Let's face it, your components won't be exactly like the writer's, nor will your voltage and current requirements likely be the same. However, the schematic of the author's supply is shown in **Fig. 1** to illustrate two points. First, note that every component is operating with a large safety factor. Second, the choke in the high-voltage section is operating in a resonant circuit in conjunction with C_1. These two features are what make this supply different from most, and will be discussed below.

The resonant choke

Good voltage regulation is a prime requisite in a power supply to be used with linear amplifiers. For developing this good regulation, it is difficult to equal the choke-input filter circuit. Furthermore, the choke-input filter has other advantages. It tends to limit the peak current in the rectifier diodes, an important consideration when using high-voltage

silicon rectifiers. And it allows the transformer to operate cooler than it would in a capacitor-input type circuit.

But there is one big problem when using a choke-input circuit in a medium- or high-voltage supply. That problem is that the bleed current necessary is usually quite high, unless you have lots of money to spend on high-inductance, high-current chokes. This means that bleeder resistors with a high wattage rating are necessary, and these cost money. Furthermore, and more important from a reliability standpoint, the large quantities of heat being generated by the bleeders tend to raise the operating temperature of the supply, and this in turn will reduce the life of the components.

For example, let's take a look at an 850 volt supply. The formula given in the handbooks for bleed current is (assuming a full-wave rectifier and a 60 Hz line frequency):

$$(1) \qquad I_b = \frac{E_{dc}}{L}$$

I_b = bleed current, mA
E_{dc} = dc output voltage
L = Choke inductance, henries

With a 10 henry choke the necessary bleed current would be 850/10 = 85 milliamps. This means there is 0.085 x 850 = 72.3 watts of heat being dissipated by the bleeder. That is a lot of heat! This constant current flow also tends to heat the transformers, rectifiers, and choke.

Some designs get around this problem by using a swinging choke; that is, a choke which has a lot of inductance at low (bleed) currents, and a much smaller inductance when the heavy load current flows. Unfortunately, this approach is usually not a good one for the amateur because swinging chokes are expensive, and not readily available on the surplus market. And, then again, most swinging chokes available commercially (at less than outrageous prices) still don't have sufficient inductance to cut the necessary bleed current down as far as is desirable. Still another problem with swinging chokes is their DC resistance, which is usually large enough to contribute detrimentally to the overall voltage regulation.

Fortunately, there is a technique (not original with the author) that gets around all these problems at the same time, although it adds some new ones of its own, of course. This technique is the addition of a capacitor across the filter choke to form a parallel resonant circuit. With a full-wave rectifier circuit and 60 Hz line frequency, we resonate the choke at 120 Hz, the first and most important ripple component frequency. The idea is to use a choke with a low-inductance, high-current rating. This will guarantee a low dc resistance. Then the capacitor is properly chosen to resonate the choke. The lower limit on the choke inductance is reached when the capacitor value required begins to approach the value of the output capacitor (C_2 in **Fig. 1**). Usually a choke of about 2 henries is used, although other values are fine, depending on what you have on hand. The required bleed current with the resonant filter then is:

$$(2) \qquad I_b = \frac{E_{dc} \times R_l}{852L^2}$$

E_{dc} = dc output voltage
R_l = Choke resistance at 120 Hz
L = Inductance of choke, henries
I_b = Bleed current, mA

Now, looking at this equation, it would seem a simple enough matter to measure the resistance of the choke and then, knowing the choke's inductance and the DC output voltage, to calculate the required bleed current. But here's the hooker (remember we promised you new problems): the value of R_l can be measured, but it isn't simply a matter of putting an ohmmeter across the choke. This is because the resistance of the choke at 120 Hz won't be the same as the dc resistance, the resistance that would be measured by the ohmmeter. Furthermore, the value of the choke's inductance tends to change, depending on the current through the choke. This variance makes it difficult, if not impossible, to calculate the best value of capacitance to be used in parallel with the choke.

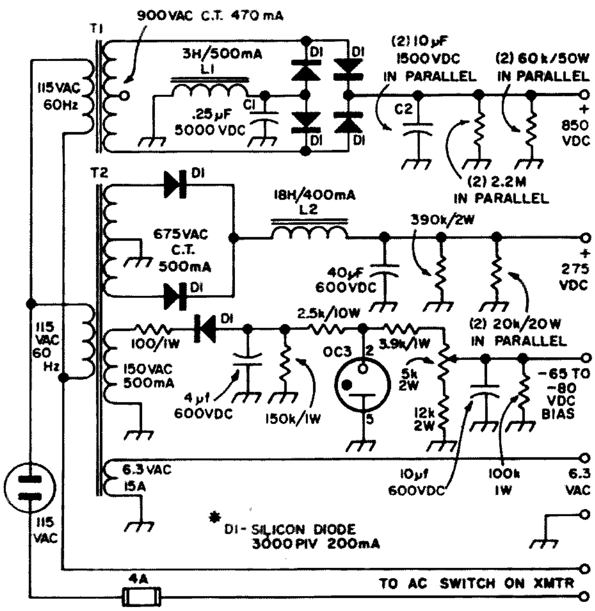


Fig. 1. Schematic of K6ZGQ's heavy duty transceiver power supply.

Once again, though, there is an answer to the problem. This time it involves what engineers call an iterative process (about the same thing amateurs call cut-and-try). Having selected the choke you will use, you want to know the proper bleed current and the proper size of capacitor to be used in parallel with the choke. Simply follow this four step method and you will come out with the right values:

1. Take a guess at what I_b should be, say 20 milliamps for each 500 volts of dc output voltage. Then calculate the size of the bleeder resistor, R_b. From Ohm's Law: $R_b = E_{dc}/I_b$. For E_{dc} use 0.9 times the total transformer rms secondary voltage if using a bridge rectifier or half this amount if using a conventional full-wave circuit.

2. Now haywire the circuit together, using R_b as calculated above. With reduced voltage on the primary of the plate transformer, say 40 volts, substitute different values of C_1, finally selecting that value that gives the *least* DC output voltage. With a 2 henry choke this will be about 0.5 microfarad. The right value of C_1 will probably be far from critical. Be sure to keep the primary voltage constant.

3. Now disconnect the bleeder resistor and measure the output voltage (continue using reduced primary voltage). Then gradually load the supply, measuring the output voltage and current at several points as the loading is increased. These points can then be used to plot a curve like that in **Fig. 2.** A good way to provide this variable load is by varying the bias on a spare transmitting tube hooked up as in **Fig. 3.** The plate dissipation rating of the tube may be exceeded as each reading is made, but if the supply is turned off between readings while the bias is reset, the tube will not be damaged.

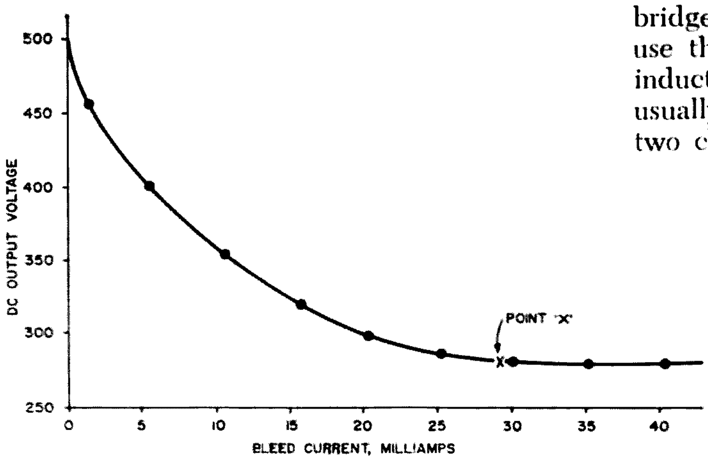


Fig. 2. Typical shape of curve that will result from technique given in step three in the text. Point X gives minimum allowable bleeder current.

4. The lowest allowable bleed current is that corresponding to point X on the curve in **Fig. 2**, that is, the point where the curve flattens out. Add about 30% safety factor to this value to get the proper bleed current, I_b. If the value obtained is very much different from that used in Step 1, use this new value and go back to Step 1, repeating the procedure. You will probably find it unnecessary to change C_1, if you do repeat the steps. And you shouldn't have to repeat the procedure more than once.

All this may sound quite involved and complicated, but it takes much less time to do than to tell about it. Be sure to observe sensible safety measures when performing your measurements. When substituting different capacitors for C_1 the working voltage rating can be any value greater than the output voltage, but don't use electrolytics. After the final selection is made be sure to use a high quality oil capacitor for this component, since the strain on it is great. The working voltage rating should be at least twice the dc output voltage.

The above process has assumed that you have already chosen the choke you will use beforehand. If a choice between two or more chokes is available, these facts should be kept in mind. First, it is desirable that the choke have as low a dc resistance as possible, in order to help provide good static voltage regulation. Second, it is desirable that the bleed current be as low as possible, and from Equation (2) it is obvious that the higher L is and the lower R_1 is, the lower the necessary bleed current is. Thus, the ratio L^2/R_1 should be as high as possible. If necessary two chokes can be compared by measuring their characteristics at 120 Hz on an inductance bridge. If a bridge is not available, the only recourse is to use the choke with the higher ratio of rated inductance to rated dc resistance. This will usually provide the proper choice between two chokes, and it has the advantage of pro-

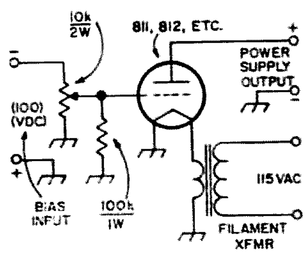


Fig. 3. This circuit shows a simple approach to providing a variable resistor for testing a power supply. Tetrodes can also be used by connecting the screen to the plate through a 10,000 ohm 10 watt resistor.

viding a choice between chokes you don't have yet—the ones in the magazine advertisements.

The reduction in bleed current that can be achieved by this method of parallel resonant filters is truly amazing. In the writer's supply the bleed current in the high-voltage section is only 28 milliamps, and this with only a 3 henry choke. And with a choke this small, it is a simple enough matter to find one with a very low DC resistance.

So now we have licked the only big problem in a choke-input design. Let's look now at this business of conservative design.

Reliability

To provide reliability in an electronic design, each and every component must be operating well within it's ratings. This means using components that have higher ratings than might seem necessary at first thought. Why do you suppose the military surplus components you buy are larger and heftier than their commercial counterpart? Because the military *must* have reliability and this requires components with a fat safety factor. (This helps make military surplus today still a big bargain in electronic components, too.)

Let's look at each type component individually and how it is selected for reliability:

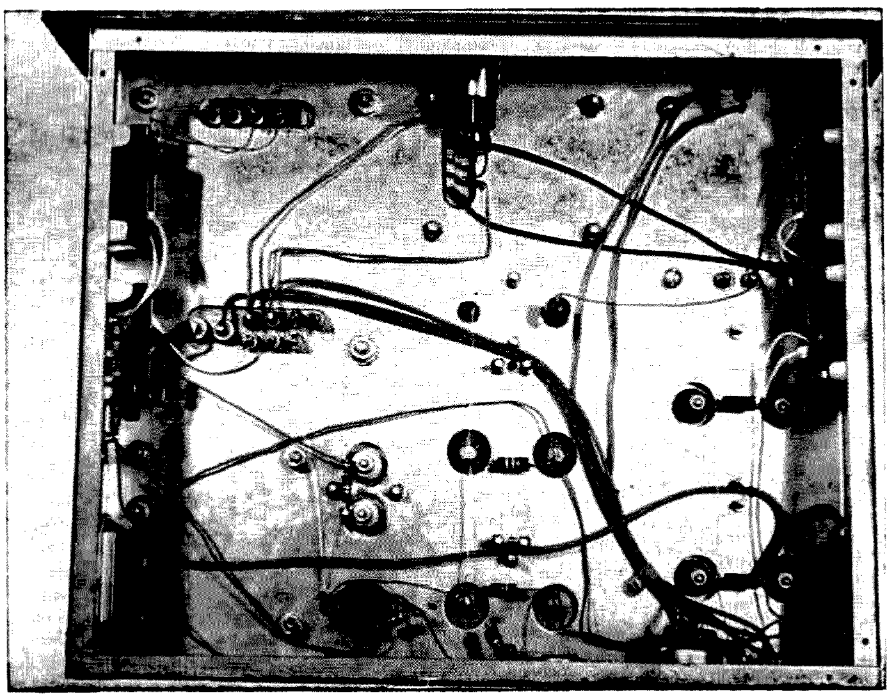
1. Transformers and chokes. These are fairly simple, it's just a matter of using components with a higher current rating than the minimum necessary. In the author's supply all the chokes and transformers have a current rating 50% higher than normal.

2. Rectifiers. Silicon diodes are the thing today. Read up on their use in back issues of this magazine. Then choose units with at least 50% higher peak inverse voltage rating than the minimum necessary. The current rating isn't quite as critical, but a hefty rating in this department is a good idea, too. The author's supply uses some beautiful military surplus units rated at 3000 piv, 200 milliamps. These are a genuine bargain available from a recent advertiser in these pages.[1] Be sure to mention 73 when writing to surplus dealers.

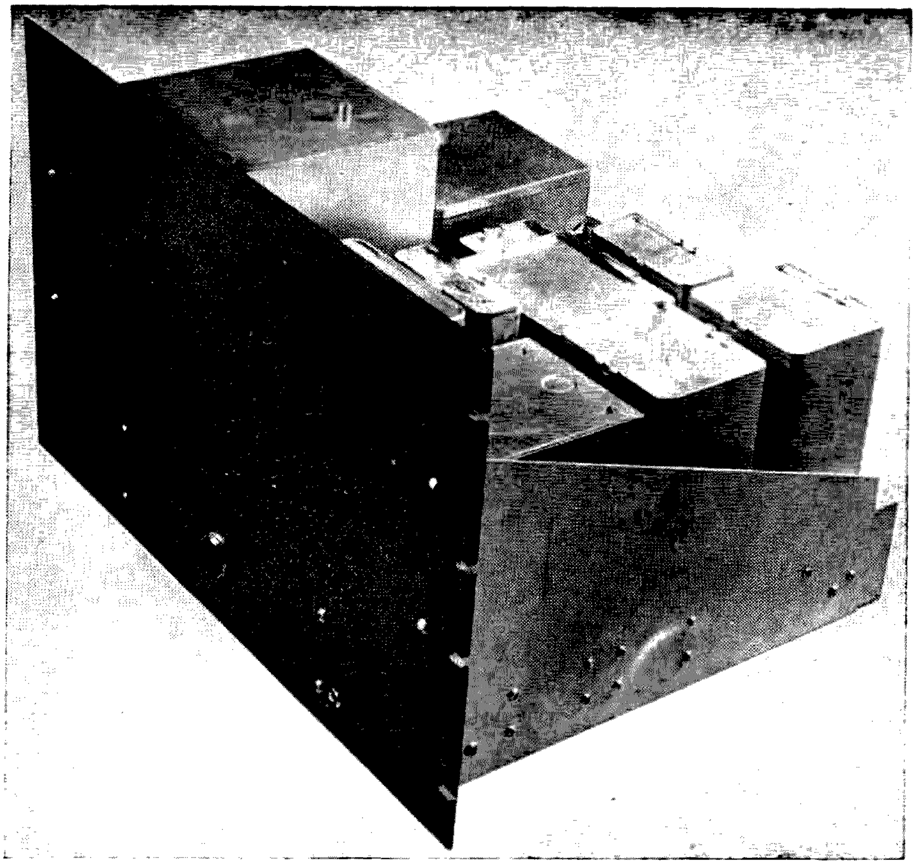
3. Capacitors. If you want reliability it is absolutely necessary that you use oil capacitors in your supply. Electrolytics just don't have very long lives. Follow the lead of the military and use oil capacitors with at least a 50% safety factor in working voltage rating. Oils are available in surplus at very reasonable prices these days.

4. Resistors. Heat and high temperatures are major gremlins in electronic equipment. In resistors, high operating temperatures limit component life severely. Consequently, resistors should have at least 3 times more wattage rating than the amount of heat they will be called upon to dissipate. This will reduce their operating temperatures considerably, and greatly increase their life. Also, note that in the writer's supply two bleeders are used in parallel, rather than a single one. This is so that if one fails in operation, there will still be some bleed to keep the output voltage from increasing sharply and causing components in

[1] Electronics Components Co. Box 2902D, Baton Rouge, Louisiana, 70821.



Underside of K6ZGQ's power supply. Components mounted on ceramic pillars on the chassis sides are the silicon rectifiers. The thick wire near the rear of the chassis connects the two high-voltage bleeders.



K6ZGQ's power supply. The transformers, chokes and capacitors have been brushed with aluminum paint for appearance.

the transmitter to fail. Also, it allows the bleeder to be divided into two parts. The two resistors are physically as far apart as possible, further reducing the operating temperature. Note that small resistors are used directly across the terminals of all filter capacitors. This is a safety precaution.

5. Fusing. To protect the rectifiers and other components a fuse with medium-blow characteristics should be used, with a current rating that is only slightly greater than that required for operation under normal conditions. Start with a small fuse and if it fails under the normal load, use the next higher current rating.

6. Note that in the high-voltage section, **Fig. 1,** the choke and parallel capacitor are in the negative lead, between the rectifiers and ground. This is to avoid having the high voltage on the choke, reducing the chance of insulation breakdown in this component.

Conclusion

This article was written for the amateur who prefers to "roll his own" in power supplies. The attempt has been to point out some facts about reliability in design that seem to have been avoided in current amateur practice. Building reliability into a design may cost a little more but it will pay off in the long run due to greatly increased life and reduced maintenance expense.

Although resonant chokes aren't new (the Henry 2-K and some Collins supplies use the idea), to the author's knowledge this article marks the first time that a fool-proof method for their use in homebrew equipment has appeared in an amateur journal.

Try the techniques outlined in this article in that new supply you're planning and gain for yourself the advantages of the choke input filter coupled with reliability.

. . . K6ZGQ/6

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VHF Antennas

Some hints gained from years of roof scrambling

About 42 years ago, the writer built a 1¼ meter parabolic beam antenna on the roof of an engineering building at college and has been climbing roofs ever since that time. There is a great fascination in building and testing VHF antennas and I suppose, or hope it will continue for a few more years. Nowadays it always means a sore back and legs for a week after each antenna test and pole raising effort, plus some scolding by my wife. At the moment I'm recovering from some stiff muscles after putting up a new 24 element 220 MHz antenna without assistance. Some thoughts pass rapidly through my mind that I'm too old to be roof scrambling, but as usual I bury that with some new ideas for repairing my even larger 432 MHz beam antenna next month, or as soon as I can obtain a couple of feet of Teflon rod for phasing line insulation. Teflon insulators are wonderful dampness-effect eliminators. I should really be making some changes or improvements in my three 144 MHz beams, some of which have been up far too long, perhaps 2 or 3 years. That is a long, long time for a dyed in the wool experimenter to leave a VHF antenna without a few changes.

Perhaps a summary of a few of the countless antenna tests that I've made, would help clarify some of the problems for others. The problem of which is better, yagi or curtain-type beams, always comes up. Curtain, or broadside, arrays always have a wider frequency coverage than arrays of yagi antennas and are generally easier to get into proper operation. Yagi arrays can be made with fewer elements for up to about 15 dB gain. Above that figure, large broadside antennas may have actually less antenna elements than equivalent arrays of yagis. When a person wants as much as 18 or 20 dB gain a large broadside array of from 64 to 128 elements may be easier to build and adjust than equivalent yagi arrays.

In terms of signal capture area or actual antenna gain, a great number of long yagi antennas will have no more gain than big broadside array. As the area spreads out for signal capture, the array depth becomes less and less important. The big broadside with thin depth may often wind up with more signal gain than long yagi arrays with great depth and "optimum" spacing. That word "optimum" is awfully hard to obtain in practice since director elements in a beam generally react unfavorably with adjacent broadside directors in other yagis.

Several years ago the writer made some tests on 1296 and later checked out again on 432 MHz. Various lengths of yagi antennas, adjusted for best forward gain into a field strength device with very low SWR on the transmission line were set up. The power into the transmission line and SWR were kept at a constant value by readjusting the matching stub and feeder taps whenever one or more directors were placed in the field broadside to the yagi. It is a time consuming job and took many days of work to check out some results. Even a single director element spaced out to the side (or sides for two) of from $\lambda/2$ to λ, produced a drop in forward gain. On the other hand, reflector elements spaced out about $\lambda/2$ always added to the forward gain when in the plane of the antenna element. Reflector elements can "work together" without losing gain whereas director elements usually do not. This occurs because a short element (director) tends to pull the field out in a direction away

from the driven element more or less in a forward direction with respect to the director position. It means that any directors off to the sides, such as in two yagis, causes some loss in the desired forward gain. The expected 3 dB power gain for two yagis or 6 dB for four yagis is very difficult to realize. If the yagis are spaced far enough apart to pick up 3 dB forward lobe gain, the minor lobes become very large and the forward lobe begins to look like a cigar shape. The array may not be held in correct position in a strong wind.

It is better to have a fairly broad forward lobe for this reason. Strong side lobes mean undesirable noise and undesired signal pickup. "Noise" means all sources other than receiver internal noise.

Any two or more driven elements in a broadside beam (reflector and driven elements only) tend to produce objectionable "side" lobes as the spacing is increased much over $\lambda/2$. At λ or greater spacings the side lobes are horrible. Yagi arrays are usually spaced from λ to 3λ to avoid director interference effects and the side lobes are apt to be objectionable. If the spacing is reduced to about ⅝ λ, the side lobes are small but the forward gain may only be increased one or two decibels as the number of yagis are doubled. A good beam antenna should always increase 3 dB in gain as the number of elements is doubled, without increasing the side lobe problem.

One way of getting the desired 3 dB added gain for double the number of elements or rather double the area of beam dimensions, is to use closer spaced, short yagi antennas. The final end result in very high gain arrays, is that a driven element and a reflector will equal the results with a short yagi for each antenna unit. The short yagis of 8 to 16 in number can be used to advantage in fairly high gain arrays. Often four long yagis can be used to advantage for antennas with gains as high as 15 to 17 dB.

Scaling down proven long yagi designs from 144 to 432 MHz usually doesn't work out very well. The directors cannot be made ⅓ as small in length and diameter, spacing and boom support material. A variation in any of these items can make a 432 MHz yagi with low gain. Lots of work goes into the design and construction of a good 432 MHz yagi. The excellent one designed by Ed Tilton (*QST*, April 1966) with eleven elements checked out at about 12 dB gain on west coast antenna measurements. Four of these could be expected to produce around 17 dB gain. This is about the same as could be had with 32 extended length and spacings in a broadside array or 64 elements in a standard $\lambda/2$ length and spacings. The 44 elements in the four long yagis are intermediate in number as compared to the two broadside arrays.

Short or medium length yagi antennas can be made without reflectors and with a gain of about one decibel more than a standard yagi on the same mounting boom length. These yagi antennas are known as director beams since no reflector element is needed. The front to back ratio of lobes is similar to that of a standard yagi and may often be superior. The forward side lobes are quite similar to the standard yagi. The spacings for maximum gain between yagis is about equal to the boom length or higher, whereas the standard yagi spacing is usually from ¾ to 1 times the boom length. **Fig. 1** shows the forward gain which can be obtained from a single yagi of both designs. These are about maximum values which can be obtained in practical designs and it is very easy to get much less gain. It can be seen that the two curves begin to approach each other for long yagis.

Stacking two yagis in broadside will give from 2 to 3 dB more gain, with the smaller gain values occurring for smaller broadside spacing. The forward side lobes are always less for smaller spacings and usually a spacing of ⅝ to ¾ of the boom lengths, with only about 2 dB added forward gain, is worthwhile since the undesired lobes are much smaller and the forward lobe is broader. End stacking of yagis does not seem to be as critical, and close to 3 dB gain is obtainable with ¾ or greater length spacing. This holds true for any yagi design. Four yagis in a square configuration normally will add about 5 dB gain over a single yagi.

Broadside arrays generally use $\lambda/2$ lengths and spacings with a set of reflectors spaced .2 to .25 λ behind each driven element. The curves of **Fig. 2** indicate the approximate gain for the usual 4, 8, 16 and 32 driven element arrays with two sets of lengths and spacings. The ¾ λ spacing curve shows higher gain but it has greater forward side lobes and a sharper front lobe. For a given number of driven elements (and similar number of reflectors), the wider spacing and greater lengths add up to more capture area, and higher gain. Values from the curves show about 12 dB for an 8 driven element array of 16 elements for the usual lengths and spacings. The extended version has about 15 dB gain in a forward direction. Both arrays would use 8 reflectors of the same length in either design. The driven $\lambda/2$ elements are actually about 5% less length than the reflectors. In any case equal length phasing lines to all driven elements, can be

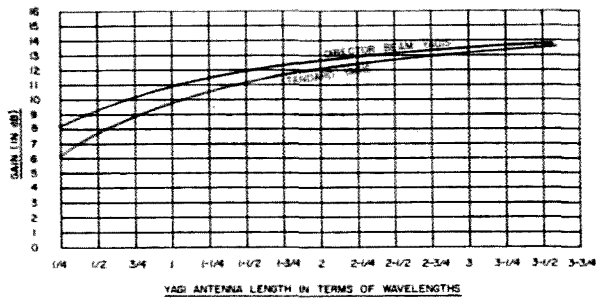


Fig. 1. Forward gain versus length for director beam and standard yagis.

made resonant and the whole array tuned to the desired band of frequencies with a quarter or half wave tuning stub at the common junction of these lines.

Three examples of practical beam antennas are shown in **Figs. 3, 4, and 5.** These antennas have been in use at W6AJF for several years. The relatively small director beam of two yagis in **Fig. 3** is actually half of a larger beam which was cut in two in order to have a vertical and a horizontal 144 MHz beam on the same pole. The original square configuration had about 15 dB gain. Now each beam has about 12 dB gain but both polarizations are used in this area, so two beams are needed. This is a director beam with no reflectors and each yagi has about 10 dB gain. Two in broadside with relatively small spacing provides between 12 and 13 dB forward gain. An advantage of this beam is the simple feeder system, one phasing line and one tuning stub which can be either an open stub roughly 20 inches long or a shorted stub about 40 inches long. The latter is desirable as it can be grounded to the tower at the center of the shorting wire for added lightning protection. A 27 inch $\lambda/2$ balun and coax line connection can be made at point "C" in **Fig. 3** or a few inches above the shorted tuning stub for the $\lambda/2$ design. In any case the tuning stub is used to resonate the whole array to about 145 MHz with an accurate GDO while the antenna is a few feet above ground and pointing upward. The balun taps at "C" are also made at this time by using an SWR meter and transmitter. When the tuning stub is the right length and the balun taps are at the correct points, the SWR will be near unity at the desired frequency. Putting the antenna up in the air on a tower or TV mast will then probably raise the SWR reading to perhaps 1.2 which is within reasonable limits. This method saves a lot of mast climbing. The writer often uses TV push-up masts and makes these adjustments with the antennas in place but within reach from the roof of the radio shack. This requires considerable roof scrambling—an old story to this radio ham.

The antenna dimensions are all given in **Fig. 3** for the 144 MHz beam. Similarly, the values are shown for the 220 MHz beam in **Fig. 4** and 432 MHz in **Fig. 5.** All phasing lines and tuning stubs were made with number 14 wire spaced from ½ to 1 inch with poly insulators or Teflon insulators spaced 8 or 10 inches apart. Number 14 wire can be melted into the center of a short poly rod by holding a 150 or 200 watt soldering iron on the wire adjacent to the insulator. Teflon insulators require a hole smaller than number 14 wire and the wires forced thru these holes. Teflon is far better for foggy or rainy weather. The writer has no snow problem.

The 220 MHz beam of **Fig. 4** is a standard yagi design except that the rf feed is a little unusual and very simple. The driver elements of all four yagis are extended out to about ⅝ λ in length and end fed with a single phasing line and shorted tuning stub. The latter is a little over $\lambda/4$ in order to resonate the whole system to 222 MHz. The end spacing is limited to about 40 inches because of the ⅝ λ driven element lengths. For convenience the broadside spacing was also made about 40 inches. The antenna gain with four 4 ft. yagis (6 elements each) is approximately 14 dB which is about 2 dB more than could be obtained with a standard 16 element broadside beam. The latter requires more area space on a pole. Either two or four short or medium long yagis usually require less area space and provide more gain than a standard 16 element broadside of $\lambda/2$ design (see **Fig. 2** for eight driven elements).

Getting into high gain beams, such as needed on 432 MHz, the broadside beams come into preference usually. The one shown in **Fig. 5** was up for several years at W6AJF until poly insulator crazing, wind and bird collision damages forced its temporary retirement. It is due for an overhauling and substitution of Teflon insulators. It has an approximate gain of 18 dB when new and shiny. All

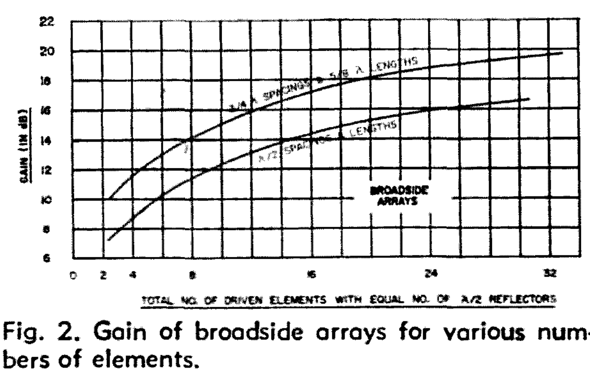


Fig. 2. Gain of broadside arrays for various numbers of elements.

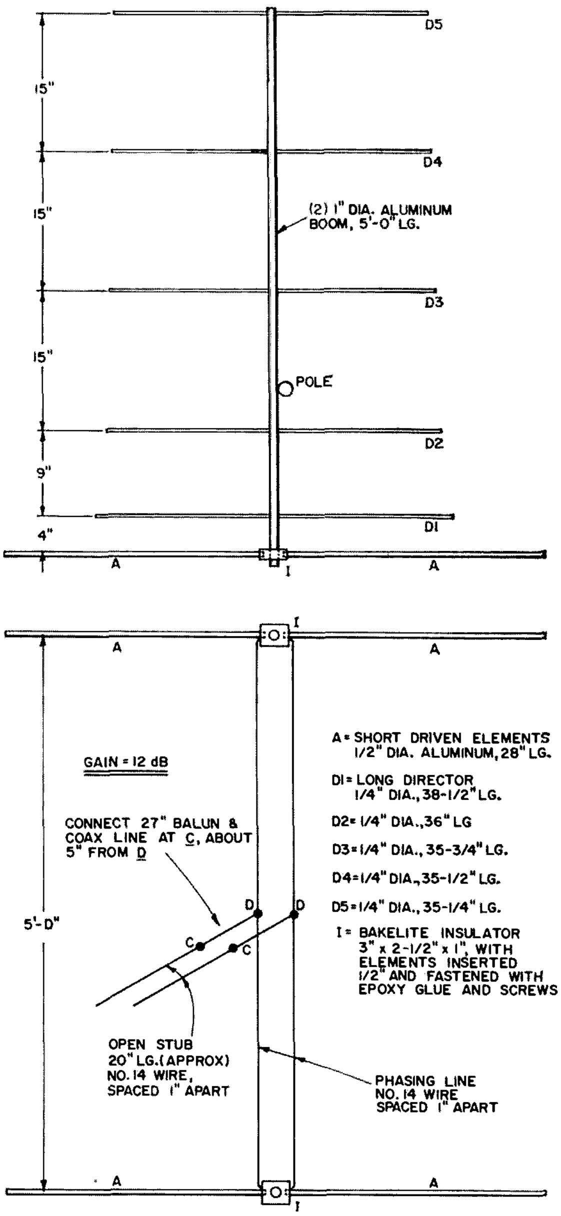


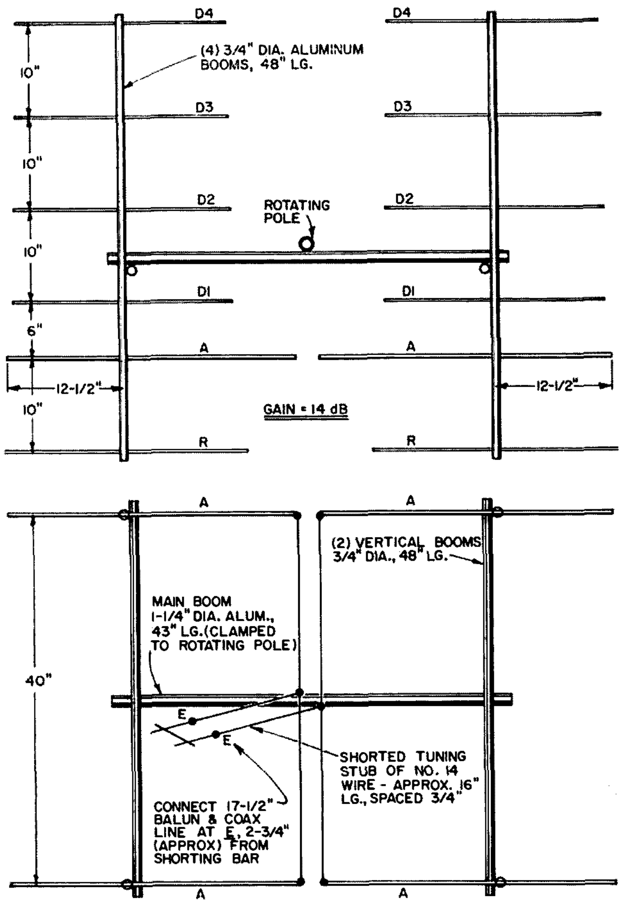
Fig. 3. Relatively small and simple pair of director beam yagis giving about 12 dB gain on two meters. Notice that this antenna uses no reflectors.

432 MHz beams tend to deteriorate from 1 to 3 dB with weathering, and corrosion of elements, so should be rebuilt and shined up occasionally.

The **Fig. 5** beam uses extended elements $\frac{5}{8}\lambda$ long in the driven elements and $\lambda/2$ reflectors. The broadside spacing between driven elements is $\frac{3}{4}\lambda$ and the rear elements (reflectors) are about $\lambda/4$ behind the top portions of each driven element. The writer is not convinced that $\frac{5}{8}\lambda$ broadside spacing is not better than $\frac{3}{4}\lambda$ because of less spurious lobe amplitudes. $\frac{5}{8}\lambda$ spacing requires a different length of tuning stub and has about 1 dB less forward gain but the forward pattern is broader. The latter is an advantage in heavy winds, since horizontal directivity can be too great for average ease of operation. An antenna much over two wavelengths wide can be a real problem to hold on a correct bearing for weak signal reception in windy locations.

The writer has a 64 element "curtain" beam on 432 MHz but with so much vertical stacking (32 over 32) the top of the beam moves several inches with respect to the bottom portion and a stiff wind adds considerable QSB to weak signals. The 64 element job uses $\frac{5}{8}\lambda$ element spacing and its forward pattern is fine, better than the **Fig. 5** beam in practice. However, the top sway is a problem and the 32 element job is going back up soon in place of the 64 element beam. The wind blows most of the time here and small beams seem to be preferable for everyday operation.

The three beams described in this article are all-metal construction which seem to stand wind and rainstorms better than wooden boom construction. Because of the metal booms sup-



R = 1/8" DIA., 26-3/4" LG., CENTER-MOUNTED
A = 1/4" DIA., 31-1/4" LG., MOUNTED 12-1/2" FROM FREE END
DI = 1/8" DIA., 23-3/4" LG., CENTER-MOUNTED
D2 = 1/8" DIA., 23-5/8" LG., " "
D3 = 1/8" DIA., 23-1/2" LG., " "
D4 = 1/8" DIA., 23-3/8" LG., " "

Fig. 4. 220 MHz quad of conventional yagis giving about 14 dB gain.

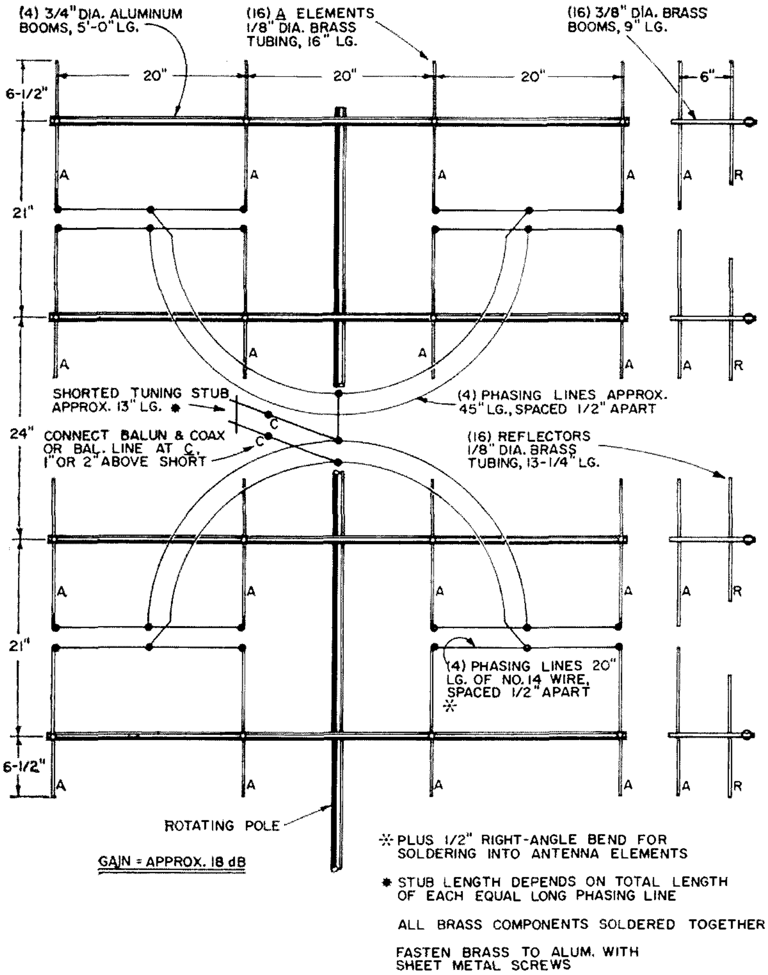


Fig. 5. High gain (18 dB) broadside beam for 432 MHz.

porting all radiating elements, the length of each element is slightly longer than for the case of wooden supports, especially in yagi antennas. The parasitic elements in all yagi beams have to be lengthened by about ⅔ of the metal boom diameter. If wooden booms are used, subtract this half inch or so from all parasitic elements (directors particularly) from the values shown. Don't expect other diameter elements than those shown to work correctly without some changes in lengths.

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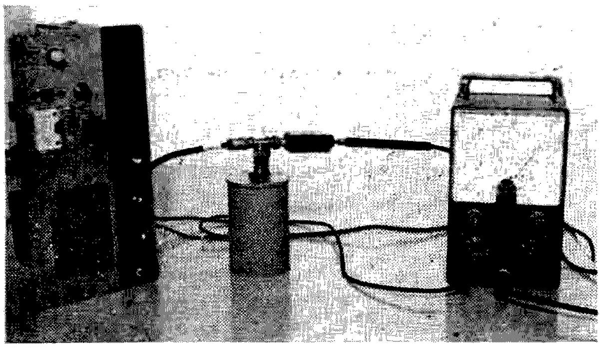


The Minican in use with the companion detector.

Sam Kelly W6JTT
12811 Owen Street
Garden Grove, California

The 'Minican'

The Heathkit "Cantenna" has proven to be a major breakthrough in the field of dummy loads for ham use. Unfortunately, it isn't the most convenient thing to use on a small work bench with low power rigs! Borrowing their idea, I built this load for use with transmitters in the 5 to 15 watt range. The parts are few: a Campbell soup tin can, four one watt resistors, a UG-254-A connector, a short piece of 5/16 inch brass tubing and transformer oil.

Fig. 1 is a sketch of the assembled unit. The 50 ohm resistance was made up of three 15 ohm and one 5 ohm one watt carbon resistors.

First sand a can lid from a larger size can until it is free of paint. Drill a ½ inch hole through the center of the lid, and a ¼ inch hole on the perimiter. Mount the coaxial connector through the center hole. Solder a 1 inch length of 5/16 in. brass tubing over the ¼ inch hole. Solder the resistors as shown. Center the lid on the can and solder the lid to the can. Use a file to remove all rough edges. Mask the connector with masking tape and paint the can to prevent rusting.

Fill the can with transformer oil. A good grade of automatic transmission fluid was used in one load with no degredation in performance. However, it probably is not advisable as the fluid has a relatively low ignition temperature and might create a fire hazard.

The load was tested by running it for five hours with an input of 15 watts of 50 MHz rf. The can became warm, but the resistors showed no signs of overheating.

A maximum VSWR of 1.5:1 was obtained at 234 MHz. The measurement was made at this frequency because an automatic test set was available.

A companion rf detector unit shown in **Fig.** 2 was built in a two inch section of ¾ inch square extruded brass stock. A Dage 394-1 BNC connector is mounted on one end for connecting to the RF circuit, while the DC output to the VTVM is a tip jack.

. . . W6JTT

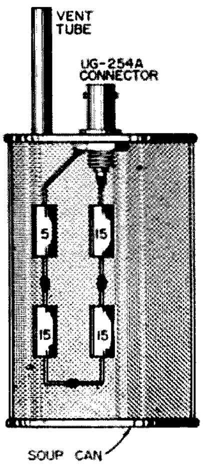


Fig. 1. Construction of the Minican. Main parts are a soup can, coax connector and resistors.

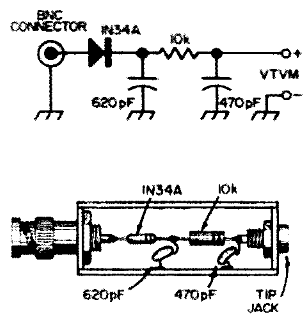
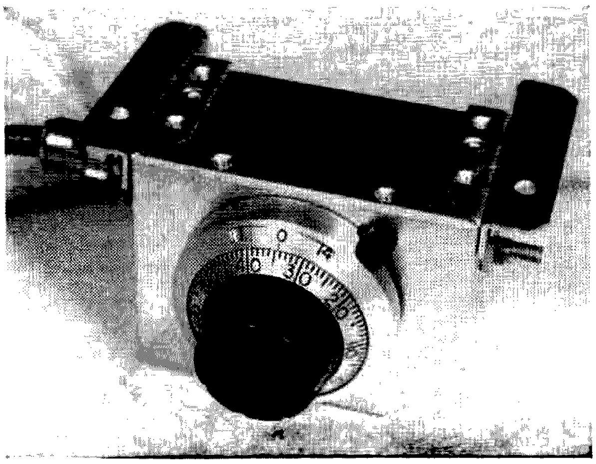


Fig. 2. Rf detector for use with the Minican.



Front view of the six or two meter VFO using a piston tuning capacitor as shown in Fig. 3.

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1674 Morgan Street
Mountain View, California

A Stable VFO for VHF or HF

These simple VFO's are inexpensive, small, easy-to-build—and provide excellent stability.

Like to build a small, simple, inexpensive, stable VFO for VHF or HF use? If you would, this article tells you how. The basic VFO described here drifts less than 80 Hz total in three hours, yet can be built very easily. The VHF model of the VFO is shown in **Fig. 1.** It can be used on six or two meters as it furnishes 24 or 25 MHz output with an oscillator in the 8 MHz range. The high frequency model shown in **Fig. 2** is designed for use with an SSB mixer and operates at 5-6 MHz. Two methods of tuning are shown. One uses a conventional air variable capacitor. The other uses a piston trimmer capacitor which offers very small size, excellent stability and easy tuning.

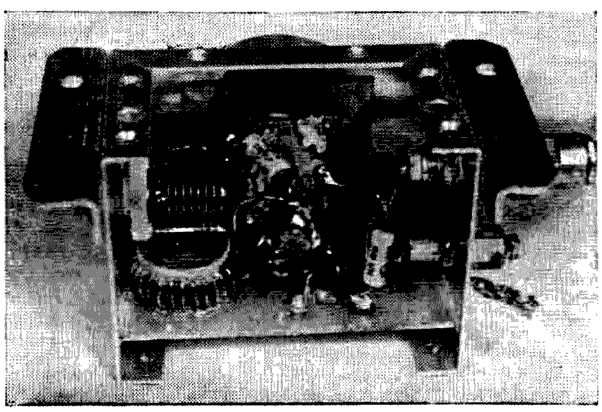
Circuit description

The circuits of the two models are similar. Each starts with a modified high capacitance Clapp oscillator using a toroidal coil. The coil (L1 in each case) is wound on a small toroidal form and features a very high Q (around 250) on a Boonton Q Meter. The coil and the capacitors C1 through C6 form a resonant frequency at the VFO frequency. Series tuning is done with C1 through C4. C1 is used to set the basic frequency range, C2 is for temperature compensation, C3 is the calibration trimmer and C4 is the tuning capacitor. The range of C4 is determinded by the frequency coverage desired. On two meters, 10 pF is more than adequate, but this value only gives 1.8 MHz range on six. For the 5-6 MHz range, 70 pF of range is needed to cover 1 MHz. This means that the capacitor must have a maximum value of about 75 pF.

C5 and C6 form a capacitive divider for feedback voltage. Using the same value for both capacitors insures that the feedback circuit is balanced. Changing the supply voltage affects the VFO frequency very little so a voltage regulator is not required.

Output is coupled from the emitter of the oscillator with a 100 pF capacitor. Don't use more than 100 pF because of loading effects on the oscillator circuit. The lowest value that can be used is best.

The second stage of the circuit (Q2 and its circuitry) is used as an untuned buffer at the same frequency as the oscillator in the 5-6 MHz VFO. Its output is low impedance from the emitter. In the two or six meter model, the second stage is a tripler to about 24 MHz with an rf choke in a broadband collector



Inside of the portable VFO for six or two showing the construction.

circuit. The output is high impedance and used to drive a vacuum tube grid at this station.

The circuits in **Figs. 1** and **2** both perform well. I've built the two meter and 5-6 MHz versions, but it should be easy to cover six with the two meter model by reducing the value of C1.

Construction details

The VFO's shown in the photos are the results of using the same basic ciruit but using different construction techniques. The toroidal coil LI used in both models is constructed by winding heavy gauge wire on the proper toroidal core. A good stable core with high permeability is a neccesity. Several manufacturers make suitable cores. I used a Micrometals core, which can be obtained from Micrometals, 72 E. Montecito Ave., Sierra Madre, California, or from one of their representatives. They have a minimum charge of $10 per order, but for $10, I was able to obtain a life-time supply of cores as each is very inexpensive when you buy a large number. I'd recommend that you write for their catalog and then order the cores.

If you'd rather not buy so many cores, Ami-Tron Associates, 12033 Otsego St., North Hollywood, California, will sell you an individual core for only 60¢ postpaid. You can also make up the proper coil inductance with the Ami-Tron RF Toroid Balun Kit available at many radio distributors.

After winding the wire on the core, the coil should be given a heavy coat of Hi-Q varnish or dope to prevent the wire from moving. All the capacitors in the circuit must be of good quality. A temperature-compensating capacitor is used to correct the minor drift in the circuit. All frequency-determining components must be securely mounted to prevent change in frequency due to movement of parts and wires.

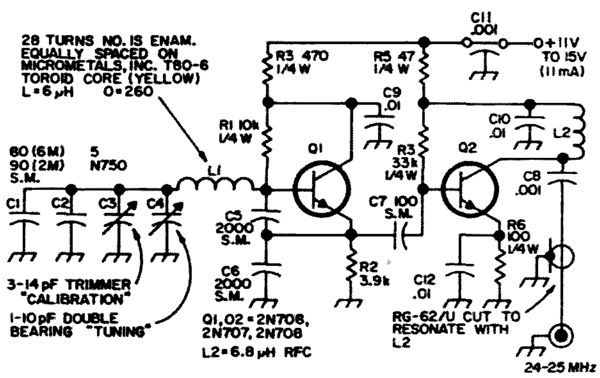
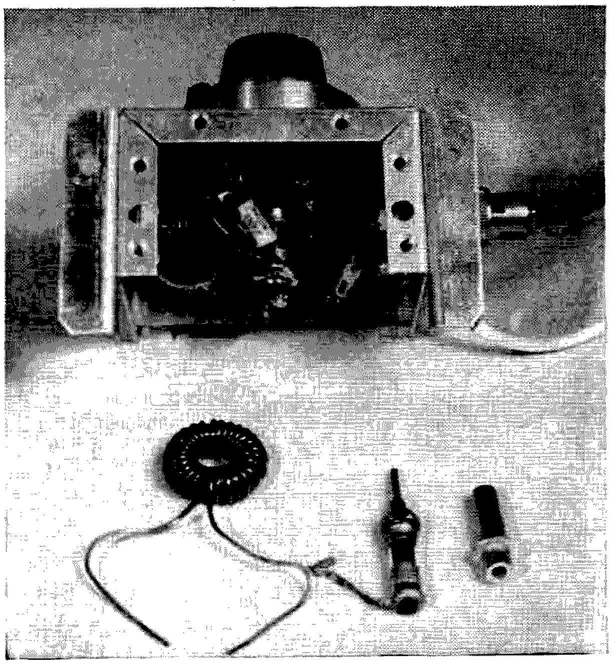


Fig. 1. Six or two meter transistor VFO with output on 24-25 MHz. The oscillator operates on 8-8.3 MHz.



Parts for the portable VFO. This VFO was made for two, but can be used on six with minor changes, or on 5-6 MHz.

Mobile VFO for two or six

The two meter VFO shown in the photos was built in a small package for mobile use. This VFO used a piston capacitor. Oscillator parts, transistors and the toroidal coil were mounted on a section of insulated board and cemented to the box with epoxy. This unit was built in a hurry for use during a trip so a few short cuts were taken. The box used was an LMB tight fit chassis box with self-tapping screws to fasten down the edges, but a sturdier box would be better. The tuning capacitor (C4, 1-10 pF) used in the two meter model came from surplus. This capacitor was mounted on a U-shaped bracket with its shaft moved by a stationary bushing (see **Fig. 3**). A hollow shaft was drilled out for a very tight fit over the bushing. This allows the capacitor to be turned with practically no backlash. A turn-count dial was fastened to the front of

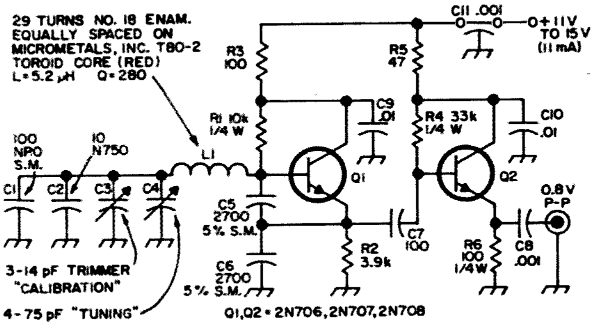
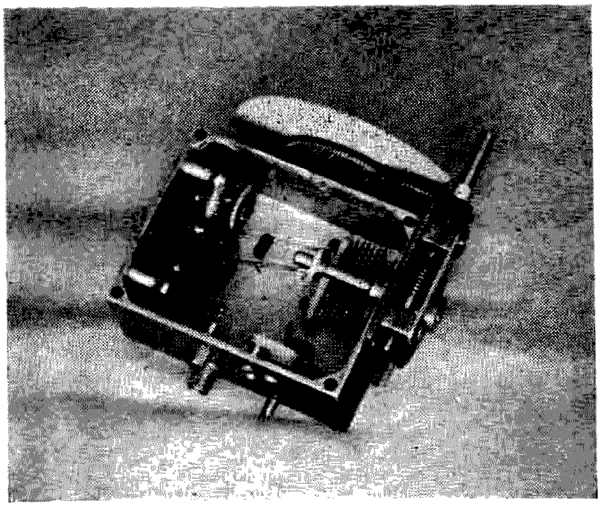


Fig. 2. Transistor VFO for 5-6 MHz for SSB mixing service.



Construction of VFO using parts from a command set transmitter dial.

the VFO box and a calibration chart was made. With 22 turns, the capacitor has about 9 pF of travel, or from 8.0-8.3 MHz on the VFO. This resulted in a very stable VFO which could be tuned to zero beat while driving.

5-6 MHz VFO

This VFO used different construction than the two meter one. The VFO parts were mounted on the insulated board as described before, but the box and tuning mechanism use a different technique. The box used was made from heavy cast aluminum found in a surplus store, with a cover fabricated from ⅛ inch aluminum. A sturdy double bearing capacitor was used for tuning. A gear drive and dial assembly from an ARC 5 transmitter was adapted to the VFO. This gear assembly gives plenty of bandspread with smooth tuning and very little backlash, though the mechanical work was a bit tedious. 48 turns are required to cover the 1 MHz range from 5-6 MHz, which is very nice for SSB tuning. A round plastic dial was cut out and installed in place of the original dial.

Both VFO's have given very good results. The two meter model in particular has provided much better stability reports than commercial VFO's.

. . . K6RIL

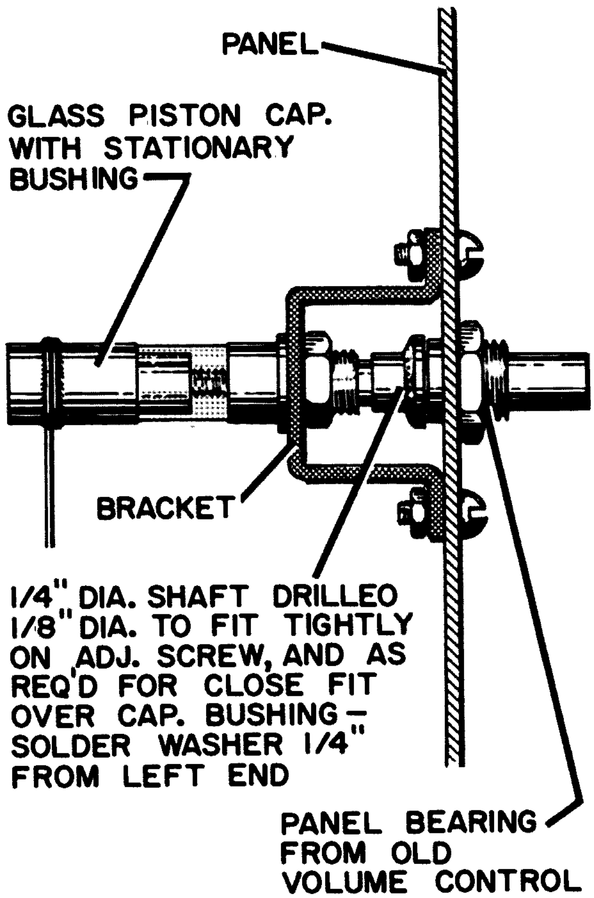


Fig. 3. Mounting the piston trimmer used in the portable VFO. A regular tuning capacitor can also be used.

WWV Moves

The National Bureau of Standards radio station WWV is moving from its present location in Maryland to Fort Collins, Colorado where it will commence operations at 0000 hours Universal Time on 1 December 1966. This is equivalent to 1900 EST, 1800 CST, 1700 MST and 1600 PST—all on November 30th.

WWV is very important to amateurs because of its standard frequency and time broadcasts; thousands of QSL cards are annually mailed to amateurs all over the world. To commemorate the opening of the new WWV station at Fort Collins, special *First Day QSL Cards* will be sent to each amateur who receives WWV on its first day of operation. In addition, the three amateurs showing the earliest reception time will receive a framed color photograph of the scene appearing on the QSL card.

Recipients of the WWV broadcast who wish to qualify for the First Day QSL Card will be required to correctly quote the new WWV voice announcement and have their reports postmarked before midnight December 2, 1966, local time. Cards should be addressed and mailed directly to David H. Andrews, Chief, Frequency-Time Broadcast Services Section, Radio Standards Physics Division, National Bureau of Standards, Boulder, Colorado, 80302.

ONCE IN A while a quiet little revolution occurs that changes the entire complexion of amateur equipment design. Such a revolution was the acceptance of SSB in the 1950's. Today we have the equally significant emergence of the field effect transistor (FET).

THE IMPACT of the FET is certainly apparent to us at DAVCO. After all, there've been 12 articles on them this year in 73, QST, and CQ alone, and over a thousand in the other engineering journals. In case you've managed to miss every one of these, all the excitement is about a device that takes the advantages of tubes and transistors, adds a few of its own, gets rid of lots of previously never-solved problems, and has no offsetting disadvantages.

FET'S AREN'T really new, nowadays. They've been used in military and advanced industrial instruments for some time. One hi-fi manufacturer started installing FET's a year ago because they provided such outstanding low-noise VHF operation and resistance to overloading and cross-modulation.

OVER A YEAR AGO, DAVCO adopted a matter-of-course attitude towards our application of FET's in our DR-30 receiver. Our ads said very little about them (the first announcement had letters all of 3/32 of an inch high). After all, DAVCO products have been offering top performance features and techniques unavailable elsewhere for three years now. To do so, we use transistors, FET's, a chassis design that's drawn raves from engineers everywhere (and many an envious why-didn't-I-think-of-that-first comment), even components made by our competitors when they're unquestionably best—like Collins' filters. (We'll use tubes, coherers, or reindeer antlers if we're convinced they do the best job). We've spent hundreds of hours perfecting our built-in SSB noise blanker in the DR-30. We take for granted the inclusion of a superb crystal filter for CW, and full-band coverage from 80 through 10 meters *with all crystals supplied*, and 6-meter coverage, and solid-state reliability, and ball-bearing tuning, and a whole lot of other things.

THEREFORE we've considered our application of FET's as the most natural thing in the world. We've mentioned them along with all the other things we offer. But with so much else to talk about, we haven't really shouted about them.

WHICH BRINGS us around to the point of all this.

THE REAL SUBSTANCE of DAVCO's approach to equipment is in what we *don't* shout about in our ads. We take for granted that you really do want the best that technology can offer. We know that band conditions have never been so demanding, and that you must have the absolute maximum in performance. We know you insist upon the best possible investment value.

SO ALL WE TRY to do in our ads is give the picture once-over-lightly. Our free 8-page brochure plus schematic tells a lot more. Our technical manual that costs $2.00 really gets detailed in its 44 pages.

WE'VE LEFT IT to you, though, to single out which exclusive DAVCO feature means the most to you. There're lot of them to consider. Like FET's.

BUT THERE'S one thing we know you're interested in. That's performance. And the DR-30's performance is outstanding.

MAYBE WE'LL start shouting a bit . . .

For further information see page 45.

The DR-30 receiver is available on a time payment basis for as little as $17.50 a month. Write for details. Orders for unmodified DR-30's are currently being shipped within 10 days.

If you use receivers in your profession, we urge you to write for information regarding special DAVCO receivers.

mailing address
DAVCO ELECTRONICS, INC.
P. O. Box 2677
Tallahassee, Florida, 32301

Ray Hoffman W4TDI
5619 Sedgwich Lane
Springfield, Va.

The X Beam

A simple antenna with a pattern similar to a rhombic.

In the never ending effort to put a good signal on the ham bands—despite the limitations of the average location, available real estate and the pocketbook—the subject of new, better, and smaller versions of antennas holds a certain fascination. There are loaded whips, short beams, quads, multiband dipoles, short verticals, and even the big wheel.

Through all of this, the rhombic has remained aloof and serene in its plush surroundings of several acres of land and stately masts. The size requirements are usually enough to scare off even the most hardy souls, its direction is fixed and its use limited as an amateur antenna.

A recent "antenna" development, used in semi-fixed transportable installations stirred my imagination. With a little adaptation, it shows great promise as a ham antenna. Since the major part of the adaptation was cutting it down to suburban lot size, it became quite practical. If you have a space 75 feet square, you too can have antenna with characteristics similar to a rhombic.

Perhaps the most difficult part of a rhombic is four poles or trees in just the right place. On the other hand just about anyone can find a single pole or mast, approximately 40 feet high. A tree is completely acceptable and even two trees with a rope between them to put the antenna in just the right place may be used.

Fig. 1A shows a typical unterminated rhombic antenna with the major lobes of radiation. **Fig. 1B** is an antenna, that gives the same pattern, but in a different physical form. Although the appearance has been changed, it still has the same phase relationships, and therefore, directional characteristics and gain.

At first glance, there is no apparent structural improvement—five supports instead of four. Not so. The four outer wire terminations are made near ground level. Sloping the legs provides more gain at the desired wave angles and increases the capture area but best of all it eliminates a structural problem.

Figs. 1A and **2B** show bi-directional patterns. For unidirectional applications, the antenna is terminated by an impedance slightly higher than its characteristic impedance, thus greatly attentuating one lobe. However, in this adaptation no termination is desired because the bi-directional characteristics can be used to advantage.

A normal sized rhombic antenna usually has three or more wavelengths of wire on a leg, is about twice as long as it is wide and requires some pretty tall masts. Under these near ideal conditions, it may show 12-18 dB gain over a half wave dipole. Leg length, shape, and height above ground are interrelated and all affect gain.

Leg length and height are quite evident and have the same meaning as in any antenna. The shape is derived from a factor called tilt angle whose value is one half of the angle between two adjacent side legs, which in turn comes from the angle at which maximum radiation from the leg occurred. This is shown in **Fig. 2.**

Rhombic antenna design tables have been worked out in many forms and are available in several handbooks. If the reasoning in the foregoing paragraphs is correct, the data should also generally apply to our antenna, which I call an X-beam. In checking these sources, an interesting case was noted. If the legs are one wavelength long, then the tilt angle becomes 45-50° and the height is about .5 wavelength.

This, then, is the basis for the design of the X-beam—four wires one wavelength long, suspended or attached to a mast or tree some 40 or 50 feet high and sloping down to convenient trees or stub poles near the ground. The angle between each pair of adjacent wires is 90° giving a tilt angle of 45°. **Fig. 3** shows a 14 MHz version of the antenna, which has a 3-5 dB gain over a half wave dipole.

Based on the 14 MHz dimensions, the antenna will occupy a square area of about 75 feet between the legs if the center is 40 feet high.

How is the thing fed? The original version feeds the ends of two of the Vee wires and terminates the other two to produce unidirectional characteristics. For amateur work this

feed system is neither practical nor desirable since bidirectional results are desired. True, the frequency range over which the antenna operates will be greatly reduced. However, since the amateur bands are narrow and in harmonic relationship, this is no serious drawback. A convenient feed point would be the center of the antenna. Further, in order to perform properly a rhombic antenna should have out of phase currents in its adjacent legs. A tuned feeder system would be ideal for this application and is recommended if the antenna center is convenient to the shack.

Where the antenna is some distance from the transmitter it is more convenient to use coaxial line. Assuming the feed point impedance to be comparatively high, the quarter wave matching section shown in **Fig. 4** was fabricated and tried. This combination resulted in a reasonable SWR and since all items are readily obtainable, no further refinement was made at this time. Further work will be done in the future to reduce the SWR.

At this point the antenna was loaded up with the Collins 30L-1 and several preliminary tests were made. It performed well, and several comparisons made with a local ham using a three element beam showed that the X beam did indeed have some gain in the desired direction.

The next development, as one might surmise from the drawings, was to determine if the directional pattern could be switched 90° in some way. Of course, one could play may-pole with the legs and do it, but there is another and more subtle way—switch the feed points and antenna configuration with a relay. A DPDT antenna type relay, mounted in a polyethylene box and placed adjacent to the center point does the job nicely and is connected as shown in **Fig. 5**.

Legs a and d are permanently connected to the feedline and to the cross connected fixed poles of the relay. Legs b and c are connected to the moving arms of the relay. For one direction legs a and b are connected and legs c and d are connected. When the relay is actuated legs a and c are connected and legs b and d are connected which switches the directive pattern 90°.

Now as to results—the X beam is oriented E-W and N-S on my lot. There are a great many trees in the yard—the main reason for not putting up my beam in the first place. The antenna is hung right in among them. Apparently the trees have less influence on the antenna than one would expect since the directional pattern is well defined. Switching the beam on a station in Florida shows a dif-

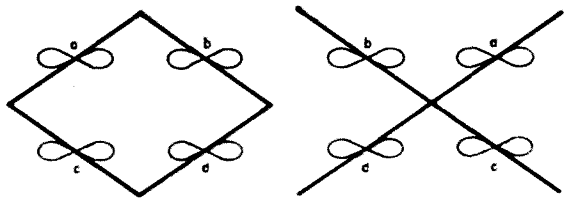


Fig. 1A, left. Rhombic and its pattern. 1B, right. X beam with characteristics similar to a rhombic.

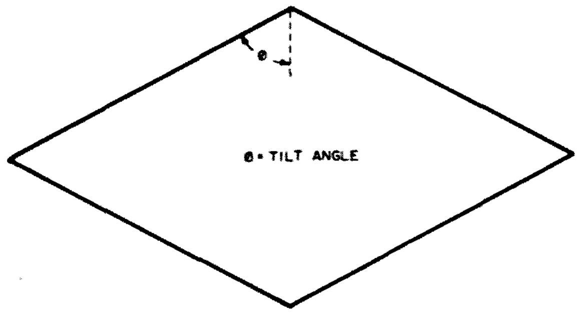


Fig. 2. Tilt angle of a rhombic.

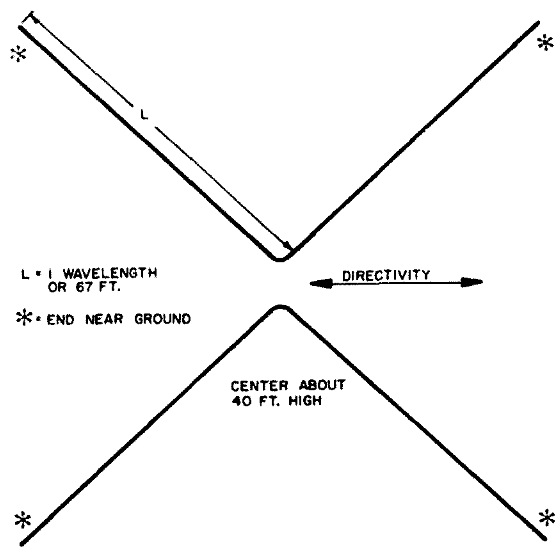


Fig. 3. Configuration of the X beam.

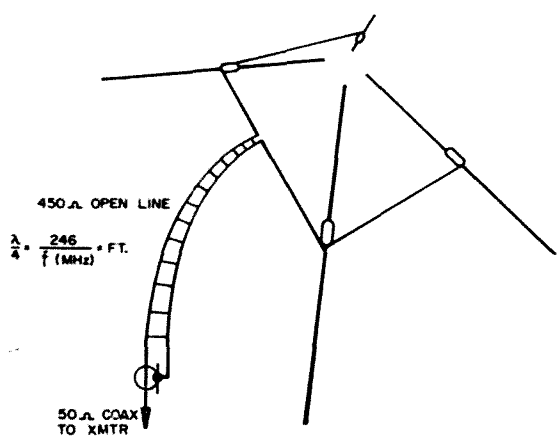


Fig. 4. Matching section for the X beam.

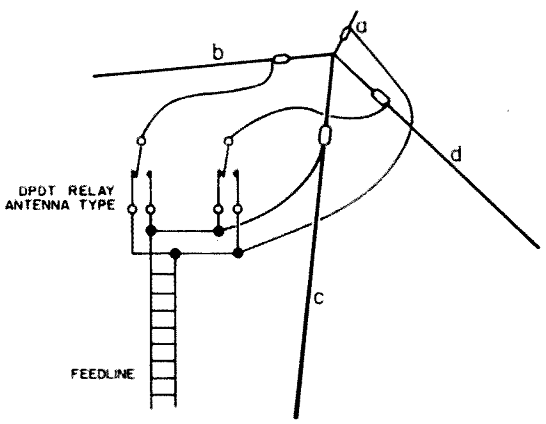


Fig. 5. X beam with switchable pattern, which gives an effect similar to rotating the antenna.

ference of about 20 dB and the Europeans go up some 15 dB when the pattern is in their favor. Some stations do not change at all, due to their being between the major lobes. Reports have been excellent and the percentage of calls answered is quite flattering.

The 20 meter X beam might well be expected to perform to some degree on most of the amateur bands. In an attempt to ascertain what it would do, an SB-33 was borrowed for a week-end and connected to the feedline. No change of any kind was made in the feed system designed for 14,300 kHz. Results were interesting and although not conclusive, they do present an area for further experimentation.

4.0 MHz operation—several stations contacted with good reports. No significant change when relay activated.

7.0 MHz operation—several stations worked within 800 mile radius with excellent results. A noticeable change when directivity was switched. Not enough data was collected to determine exact characteristics.

21.0 MHZ operation—performance very similar to 14 MHz. Unfortunately the population of this band at this time is too sparse to completely evaluate performance.

As a final test, one kW of rf was pumped into the feedline. Since nothing smoked, melted or made funny noises, it can be concluded that the SWR that exists on the line is not a serious drawback to all-band operation!

Another antenna of this type was constructed in the area. It uses tuned feeders and all band operation is indeed quite interesting—it does very well on all of the popular frequencies. The builder noted about the same performance as the original but was able to match the system much better using the tuned feeders.

My thanks to the gang on 20, whose many reports helped the cause. The Northern Virginia group were most kind—putting up with my many breakins to obtain comparative readings.

. . . W4TDI

A Home Brew Rectifier

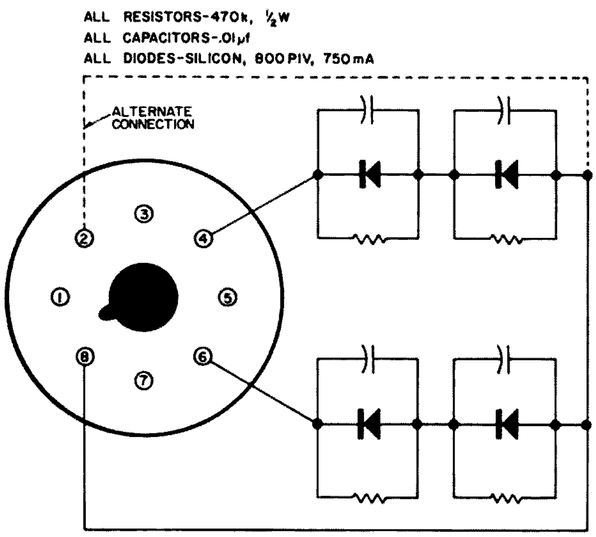
Diodes are being used more frequently in the replacement of vacuum tubes and offer several improvements. The circuit shown is a full wave rectifier with the diodes replacing the tube. The capacitors prevent the voltage spikes from damaging the diodes and the parallel resistors equalize voltage drops across the diodes. No surge resistors were needed as the resistance of the transformer secondary was high enough to limit the charging current below the diode rating. This rectifier, with proper diodes, may be used to replace the 5Y3, 5U4 and 5R4 tube rectifiers.

Some of the advantages that may be utilized upon using this rectifier are: compact size, little heat, long life, no glass envelope to break, higher output voltage (amount depending upon capacitor), or choke input filter, no filament voltage needed.

The commercial versions of this type rectifier sell from $2 to $5, depending upon the peak inverse rating. This home brew rectifier was very cheap as the only components purchased were the diodes and diode prices are getting lower all the time.

This rectifier has been used in an SX-100 receiver as a plug-in replacement for the 5Y3 for over the past year with fine results. The B+ voltage, under load, increased about 30 volts which was still below the maximum for the tubes involved. A plastic pill bottle may be slipped over the diodes to prevent any shock hazard.

. . . Carl Pleasant W5MPX



Richard Factor WA2IKL
Joseph Shapiro WA2ZCH
115 Central Park West
New York, New York

Remove the Drudgery from Ham Radio

Don't let the FCC close your station for altercations.

Are you sick of CW? Does RTTY break your nails? Do your gums bleed when you chew the rag? The authors, plagued with these perennial problems, have taken their cue from tape cartridges. These heretofore relatively unknown contrivances were spawned at the nation's broadcast stations where they are used to relieve the announcers of the incomparable drudgery of announcing, and the engineer, of engineering. The thought of a union engineer actually having to thread a tape (horrors) or an announcer having to read a live commercial endistraughtifies those concerned. After all, it's just their job!

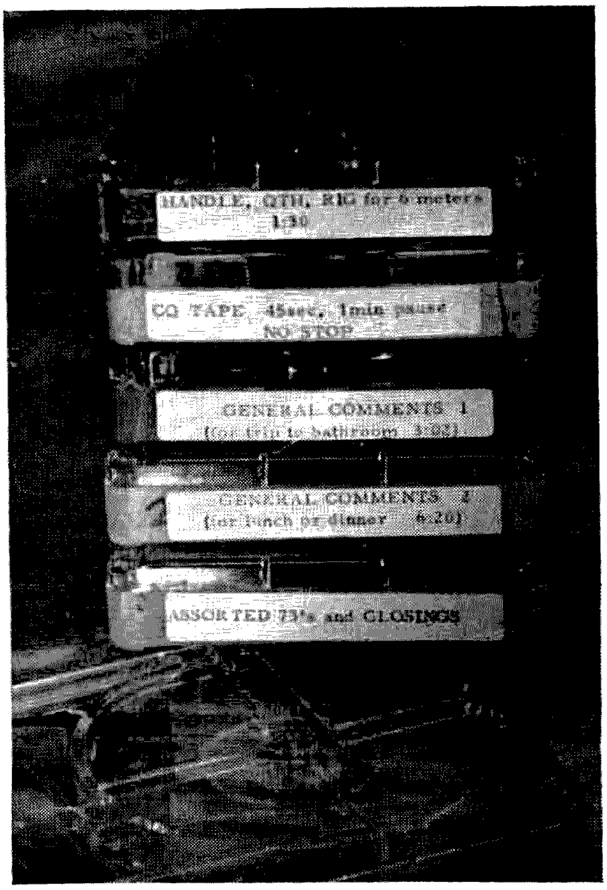


Photo by Ira Fuchs WB2CLL.

The purpose of this article, Mr. Radio Amateur, is to show you how you too can avoid the daily drudgery of going on the air and talking to your contact. If your neighbor hams don't read 73, you can be the first in your town to have a real broadcast station! What we're getting at is that, with a tape cartridge setup as described below, you will never again have to talk with anyone. All you need to do is to record several cartridges with ham-type talk and then play them in sequence.

A typical QSO might go as follows: Play CQ tape until someone answers (the cartridge conveniently repeats itself every minute.) It must, of course, be used with a VOX for unattended operation. In time someone will answer you and a QSO is born. The next step is to put in the "Handle, QTH, RIG" tape, which can be individualized for each band. This can be done simply by switching tape tracks—instructions will follow. Eventually, the tape will finish and your contact will return with some similarly uninspiring information about himself. At this juncture you have a choice: if you have been listening to the QSO (you are, of course, under no obligation to do so) and you find that the other chap is interesting, you might want to go to the trouble of speaking to him. In this case, just stop the cartridge machine and come back to him personally at the end of his transmission. If you don't, (a vast majority of cases), you need only insert the "Assorted 73's and Closings" tape and walk away. Your contact will respond in kind and you are rid of him. If he is one of those who insists on emitting a string of "final finals," the tape will really put him down.

If you are in an interesting QSO and "nature calls," just start your "General Comments" tape and make the necessary pilgrimage. This not only obviates the necessity of embarrassing yourself on the air by saying where you are going, but also saves your license from official embarrassment if you inadvertently utter an illegal synonym.

At this point you are no doubt wondering what has withheld the cartridge revolution from the amateur market. Sure you are. The basic problem has been the high cost of the cartridge players. Most broadcast units cost upwards of $500. However, mass production, the American Way, has come to the rescue. Some of the tape cartridge units for automobiles use this exact cartridge, known as the Fidelipac. These units cost less than $100. However, also in the American Way, these units have already become obsolete with the advent of the 8-track Lear Jet-R.C.A. system which has been adopted by G.M., Ford, anl Chrysler. This naturally means that the price of the automobile Fidelipac units will fall. The authors feel confident in making this prediction because, in fact, it already has. We have seen ads for one unit, the Portatape, for as little as $45. This unit includes an oscillator which converts the audio from the tape head to a broadcast band rf signal which can be fed to any standard radio. It is likely that the hams in the audience would prefer to take the output directly from the head. If you don't want the oscillator, you can buy the unit for $36. The name of the supplier for the $36 unit can be obtained from, of all places, Popular Science Magazine. Saying you saw it in 73 will undoubtedly confuse them greviously.

The Fidelipac cartridges are relatively simple gadgets (see photograph). They basically consist of an "endless loop" of especially lubricated tape in a plastic box. When they are placed in a cartridge player, a removable idler wheel pops up through a hole in the bottom and presses the tape against the capstan. The pressure pads, also in the cartridge, press the tape against the head or heads. The length of the tape can be varied so that any time interval from several seconds to a half hour can be obtained. The advantages are obvious: no rewinding and no threading.

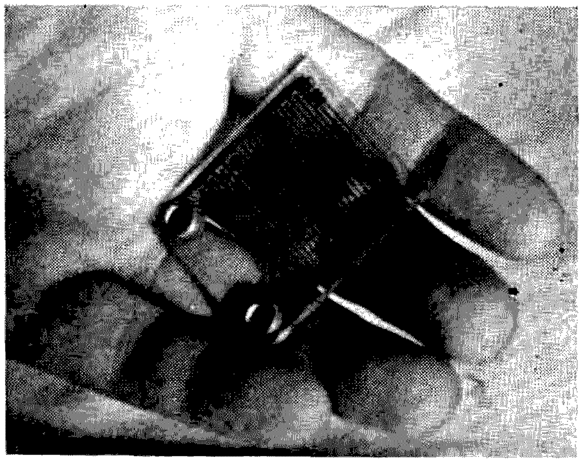
Now for the mechanics of the system. To the basic cartridge machine you must add a dc power supply for twelve volts. Since the motors have speed governors, regulation isn't important. If your player has only tape head output, you must furnish a NAB equalized preamplifier. Since most of the units will already contain an amplifier of one sort or another, just build an attenuator pad and connect it between the output and your transmitter microphone input.

There remains one problem; that of recording the cartridges. None of the machines has a record preamp. There are three ways of solving this problem. The first is to homebrew a record preamp. This is not recommended since special components are required. The

second is to use the record preamp from an old tape recorder. This will work quite well even though the heads aren't designed for recording. Besides, cannibalizing an old tape recorder is in the best traditions of scrounging. Using either of these methods will yield four discrete tracks on the tape. Thus you can tailor the comment to the band, season, weather, etc. just be selecting the proper track. If neither of the above methods is appealing (that is, if they're appalling) you can buy empty cartridges and a reel of lubricated tape such as Scotch type 151. Don't try to use unlubricated tape because you'll find (*very* much to your dismay) that it will not work. You can then use a standard tape recorder to put your message on the tape which is then wound on the cartridge. If you are unfamiliar with the winding process, it is suggested that you obtain one already wound so that you can see how it is done. It should be noted that if you use a standard tape recorder you can only record one track on the cartridge. If you use a so-called four track stereo model you can record two tracks. This is because a standard machine records alternate tracks in opposite directions while all four tracks run in the same direction on the cartridge. Although this disability can be circumvented, methods of doing so are beyond the scope of this article.

The uses of cartridges in ham radio are legion. For instance, they could be used for mobile work. We feel that this would be the ultimate in keeping the amateur's mind on the road. You can even buy or make music tape cartridges for use when the band is dead. A myriad of other uses suggest themselves. Since they suggest themselves, we won't bother.

Your friendly authors can envision the day following the universal acceptance of this grand scheme when it will no longer be necessary for hams to waste their valuable time calling CQ, and, even worse, talking on the air. Instead, they can spend their time winding tape cartridges and improving their on-the-air voices and personalities. Hams could start correspondence clubs to exchange ideas for recording cartridges, and many new technical developments could ensue, such as automatic tones recorded on the cartridges to turn on your contact's transmitter when your tape is finished. Eventually, we will reach nirvana, when all hams will have tape recordings running their stations, and perhaps even use automatic QSL printers and mailers. Then the amateur will be freed from the drudgery of personally operating his equipment and he can devote his energies to more nearly useful pursuits. . . . WA2IKL, WA2ZCH



Honeywell humidity sensor used in the Humidivox.

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The Humidivox

One of the penalties we pay for switchless SSB operation is that we sometimes forget to turn the switch when it should be turned; i.e., when we get up from the rig to do something else. All too often the VOX is left on and any noise made by an unwary or unwitting occupant of the room goes over the air. While it is only embarrassing to have others listening to family arguments, it can become downright illegal if the argument is sufficiently suffused with vindictive invective. Judging from the things I've heard on the air, this happens rather frequently.

An unfortunate characteristic of microphones is that they do not have the intelligence to know when they're being spoken to. An ideal solution to our problem is to make the microphone realize that it is only to transmit a signal when it is spoken into, even though a signal just as loud from across the room should not be transmitted. While an artificial intelligence for microphones may seem ridiculous, we can construct an electronic circuit which will "tell" the microphone when to work.

Let us examine some of the alternative circuits available: The most elementary is the push-to-talk circuit. This is quite practical, but of course it completely negates the advantages of the VOX. There are more exotic circuits, such as capacitance operated proximity relays, but these are difficult to build and adjust, and are unreliable at best in large RF fields. A photocell detector could be used to show when someone is in front of the microphone, but these are physically unwieldy and microphones (and people) have a habit of moving around. By now it might seem that the only solution is to hire someone to sit by the T-R switch, but by remembering a universally known but totally ignored characteristic of the human organism, it is possible to construct a practical solution for a few dollars in about as many minutes.

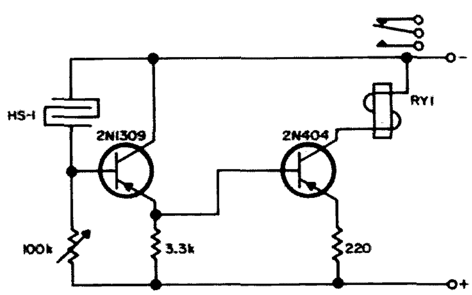

Fig. 1. Simplest version of the Humidivox. This circuit uses a humidity detector (HS-1) on your microphone to make sure that your VOX is triggered only by a person speaking into the mike.

The characteristic I am talking about is that when people talk, their breath contains moisture which can easily be detected by a number of devices on the market known variously as electric hygrometers or humidity indicators. Most of these are made with a fine grid of printed wiring on a moisture sensitive plastic surface which changes its resistance when the moisture content of the air changes. The unit I used is a Honeywell type Q229A6X1 which has a resistance in the 50 megohm range in a fairly low humidity room which decreases to less than 1 meg after a few seconds of talking at about six inches. The circuit is quite simple, using two cheap transistors in a DC amplifier. There is no particular reason why the transistors specified need be used; as long as Q1 has fairly low leakage the circuit will work. The relay you use will depend on the supply voltage. I used a sensitive reed relay which has a resistance of 690 ohms and a pull in voltage of 6V. The supply is 12V. A battery supply can be used and will last quite a while since the non-operating current is less than 1 mA, but with the prices of batteries being as high as they are, a voltage doubler connected to the rig's filament supply will be cheaper.

Fig. 1 is the most basic circuit for satisfactory operation in a constant humidity environment such as an air conditioned room. If your roof leaks or you live in an area with changeable weather, it would be a good idea to use

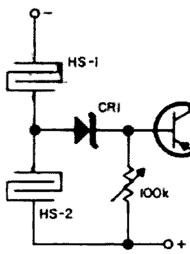

Fig. 2. This input circuit is recommended if you operate in a humid atmosphere.

the alternate input circuit in Fig. 2. In this circuit, HS1 is placed on the microphone and HS2 near the microphone but in a place where it won't be breathed on. CR1 is a zener diode whose value is approximately ½ the supply voltage. If the two sensors are of the same type, the junction voltage will be ½ the supply voltage regardless of the relative humidity; but if HS1 is breathed on, the voltage will become more negative and the diode will conduct and activate the relay.

There is one problem (actually more of a nuisance) involved with this system; that is the time lapse in the operation of the sensor. It will take one or two seconds to activate the relay after talking begins and about five seconds to drop out when you are through. Obviously, then, this relay can not control the transmitter directly. The author customarily uses a compression amplifier between the microphone and the transmitter. If the Humidivox is used to control the gain of the compressor, the problem is solved. The non-compressed gain is set so that nothing (short of a chorus of indignant mothers-in-law) could activate the VOX unless it is very close to the microphone. This makes it necessary to speak the first few words loudly, but when the Humidivox relay closes, the compressor gain increases and only a natural voice is necessary. When you are through talking, the system reverts to the state where it is impossible to activate accidentally. Note that it is not necessary to shout every time the VOX drops out, but only when you start a new transmission. If you don't use a compressor, just connect the normally open contacts of the relay in parallel with a resistor which is in series with the microphone and equal to about five times the input impedance of the transmitter.

The Humidivox is a simple gadget which can save a lot of embarrassment and costs little to build. There are many opportunities for experimentation: for instance, you could discover how to make it *not* respond to alcohol. This could save further embarrassment! If at any time you decide to go back to PTT or even CW, you can always use it to lower the roof of your convertible. . . . WA2IKL

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The Now-You-See-It, Now-You-Don't Antenna

My wife looked at the brand new house and sighed, "It's beautiful. And look, there aren't any wires or telephone poles to mar the scenery."

I choked. No poles, ac lines or TV antennas meant only one thing: the builder had spent a small fortune burying the utility wires and installing a master cable TV system. No half-wit ham was going to move in and spoil the view with an outrageous antenna farm.

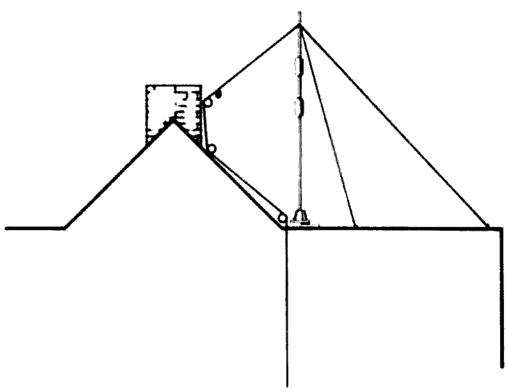
Here was my wife's dream home . . . and it happened to be a ham's nightmare. At least, I thought, it didn't have a built-in intercom set like every home in the last tract we saw. I shuddered as I thought of the probable mass "I I" (intercom interference) we would have experienced: "Who's that on the intercom, dear?" "I don't know, but I think he said he's in Guatemala."

As my wife toured the models I checked with the builder's salesman and found, as many hams are discovering in new developments, "no antennas without approval."

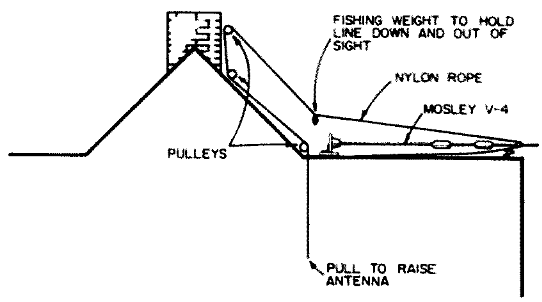
Suddenly, a thought flashed across my mind. I recalled those old World War II B movies . . . you know, the kind where the secret agent raises a mysterious antenna up from an underground hideout and transmits the coded messages home to his sinister government.

I had the answer! What I constructed, with the approval of the builder, may help other hams faced with the dilemma of esthetics over electronics.

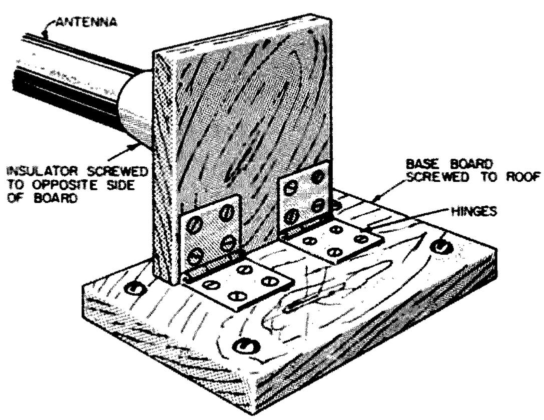
Ron is a partner in an ad agency. He's written articles for ham magazines and other magazines. He has an AB in Radio-TV Broadcasting from San Jose State College.



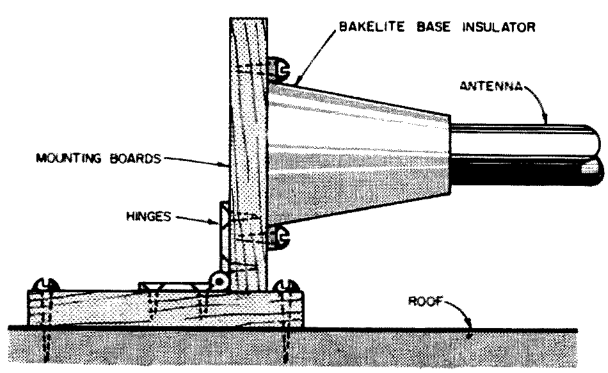
PULLING GUY ROPE PULLS ANTENNA INTO VERTICAL POSITION



VERTICAL ANTENNA IN HORIZONTAL POSITION



Antenno in vertical position.



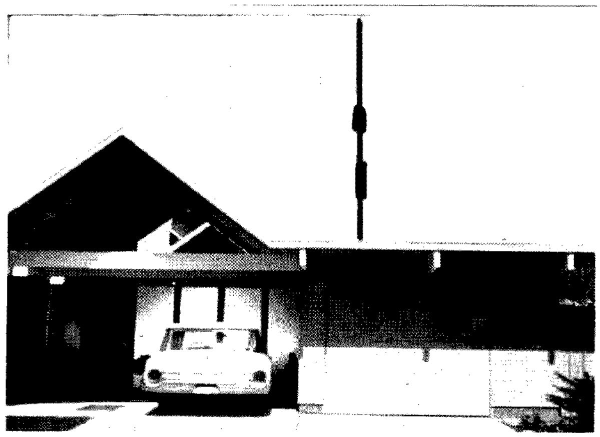
Antenna in horizontal position.

I took my Mosley V-4 vertical (any vertical antenna will do) and fastened its plastic base to a piece of board—about an inch thick by 8 by 10. On the other side of the board I screwed a pair of ordinary door hinges. They, in turn, were screwed to another 1 x 8 x 10 board securely bolted to the flat part of my roof.

Next, I fastened two nylon guy ropes to the antenna and anchored them to the roof. But for the third guy, I took an extra long length of nylon and ran it first to a pulley hooked to my chimney, then across the roof to a second pulley, then down the side of the house.

The action is simple, esthetically pleasing 99% of the time and only slightly suspicious-looking the 1% of the time when the antenna is being used. The vertical, you see, is normally horizontal—flat on the roof and completely out of sight. When I'm ready to transmit, I pull on the third guy rope, smile cunningly, and watch as my antenna slowly rises to a vertical position. The guy rope is tied to the house to hold the antenna up while I'm on the air, and released to lower it to the roof.

Since most of my operating is done at night, few of my neighbors know of the antenna's existence. And those who do simply think I'm a spy. It's better than being a ham in a "no-antenna" neighborhood. . . . W6DFT



Now you see it . . .

. . . now you don't.

G. "Steve" Stephens W9SLM
RR No. 2
Sheldon, Illinois

Home Made Custom Decals

I am sure that most hams who like to build equipment are familiar with decals. Decals give that commercial look to home constructed equipment.

Many times in the past, I have needed a special title or design that was not in my commercial package. I imagine other do-it-yourselfers have also been faced with this problem.

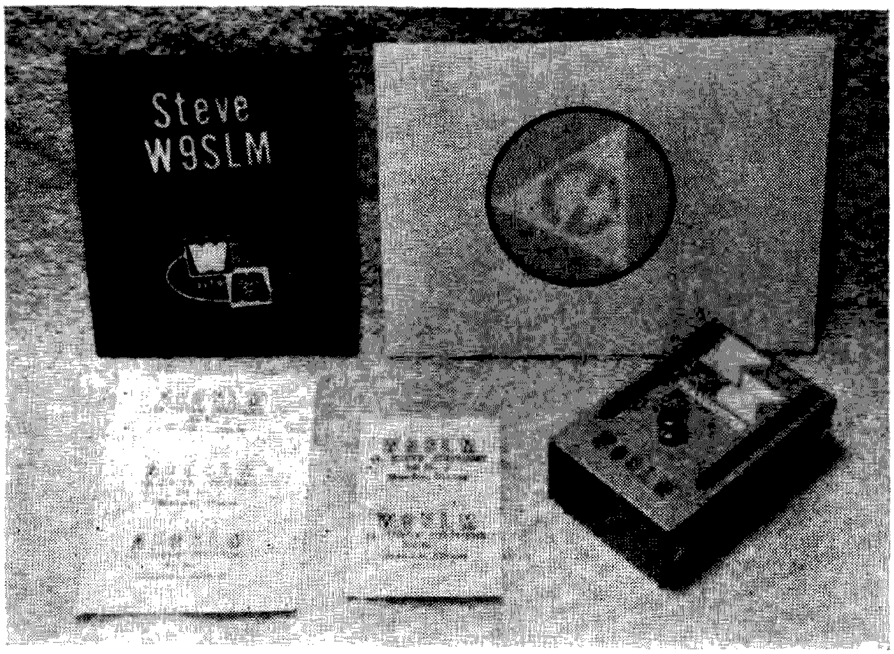
Perhaps your projects only require standard titles such as: KVA, Gauss, De-emphasis, Hot Water, Tilt, etc., whereby a commercial set of decals will do the job. Should you require a special title, however, here's how you can make it at home by a method that is easy, cheap, and fun.

See if you can find the following material in your junkbox: a sheet of decals, a rubber stamp, and a piece of glass or plastic that will provide a smooth surface onto which you can roll some thick paint. Apply a small dab of paint to the glass or plastic and roll it out into a thin layer. Gently mash the rubber stamp down into the paint to ink it. Now firmly stamp the impression onto the border of the decal sheet, being careful not to press too hard or slide the stamp sideways. If you goofed on that one, try another. A little practice will probably be needed to get the desired results. When the paint is dry, the decal can be applied in the usual manner.

Commercial decal paper and other supplies can be obtained from art suppliers. A sheet of "Klear Kote," 20"x25", decal paper, that sells for about 32 cents, will make many decals. Special inks and paints can also be purchased, but some success can be achieved with ordinary enamels.

A variety of rubber stamps can be obtained from mail-order houses, or office supply stores. One, familiar to hams, is the "Name, Call, and Address" stamp. This is available for about a dollar, and it makes fine decals for identifying your equipment. The small set of individual character stamps shown in the photograph is handy and allows setting type for about any title that you might need. These and other types are usually available in several sizes and styles.

No matter which type of rubber stamp you use, you're likely to have some trouble on your first few tries. These suggestions may help you achieve better results: First, roll the



The upper left decal was made with a silk screen. The upper right decal was made by cutting a stencil from poster board and spraying through it with an aerosol type spray can. The lower left of the photo shows several decals made with the familiar "call, name, and address" rubber stamp. In the lower right is pictured a small transistor project with lettering done in decals made by the author. The "KK" was made with a stencil cut from poster board as explained above. The "W9SLM" was made from the rubber stamp. The balance of the lettering was from commercial decal packs.

Several types of rubber stamps available at low cost that can be used by do-it-yourselfers. Also shown is a tube of stamping ink.

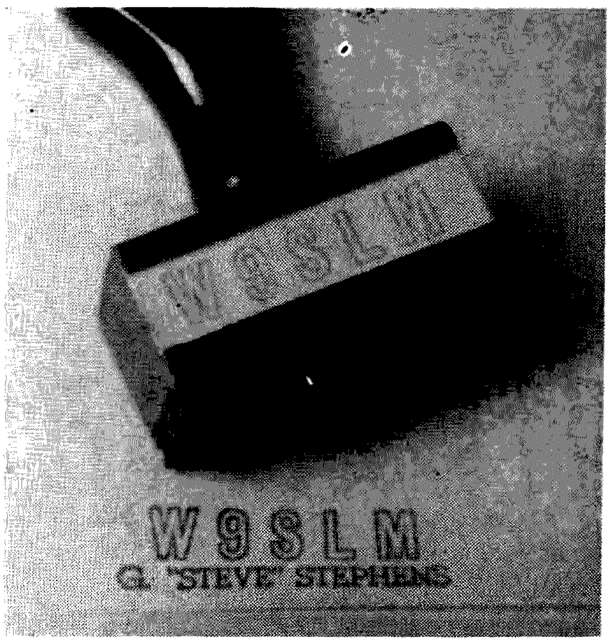
paint into a thin film and do not press too hard on the stamp. Thick layers of paint or too much pressure will fill in the letters and make them smear on the decal sheet. This is the most important step, as it will make the difference between a clean, sharp impression and a smeary one. Second, after the decals are stamped, clean the rubber stamps with a thinner or solvent that will not dissolve the rubber. Pay special attention to removing the paint from inside the characters, as once it dries it is difficult to get out. Third, the consistency of the paint should be thick so it will not run or leave a dim impression on the decal sheet. Fourth, the stamp itself should be sharp, as it will print only as clearly as its letters are sharp.

I have also had some success in making designs for decals by cutting stencils, placing them on the decal paper, and spraying through them with a spray paint can.

Should you desire to produce a large quantity of the same decal, such as for a club project, a stencil cut on a mimeograph master sheet will serve the purpose, and it can be run off at home. And, if you're really enterprising, you can devise other jazzed up gimmicks for making truly unique decals.

That's it men. If you've been looking for a special title or design in a decal that isn't in your commercial package, try my method, and it will give your latest creation that custom appearance.

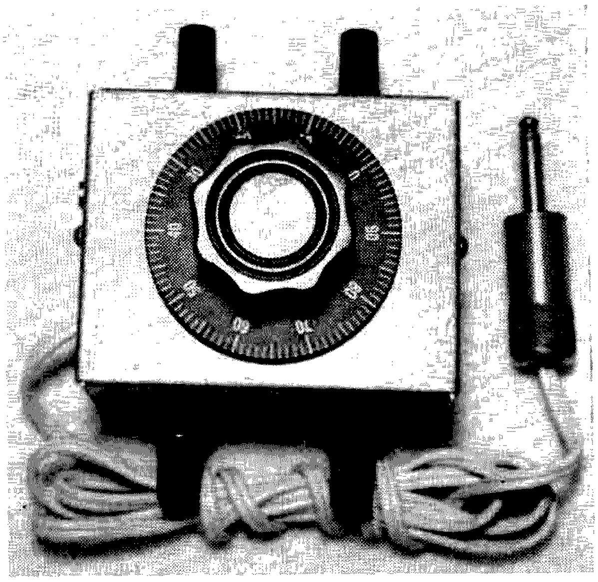
. . . W9SLM



A quick sample impression that can be readily made to try out this method of making decals.

Houston Gene Dewey WB6AFN
314 East G Street
Ontario, California
Photo by Robert Rathburn.

A Simple C-R Bridge



WB6AFN's simple capacitance-resistance bridge.

Are you looking for a simple gadget to match resistors, and to measure accurately the values of those unmarked surplus capacitors? Your problem is solved. This little instrument is not only simple, but also cheap, versatile, and accurate.

Note on the schematic that the ac source and null indicator are not included. Inclusion of these would only increase the building cost. Most hams have an ac source readily available. You can use a 6.3 Vac transformer, an audio generator, code practice oscillator, or your ham receiver. (Turn on the Xtal Calibrator on the receiver; tune to loudest beat note; plug the bridge into the phone jack. Simple.) The null indicator may be a VOM, VTVM, or a pair of headphones.

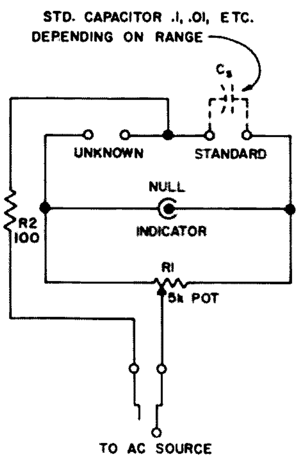
Calibration is accomplished in two parts. First, find the median resistance. Second, calibrate the bridge to measure capacitance.

Finding the median resistance

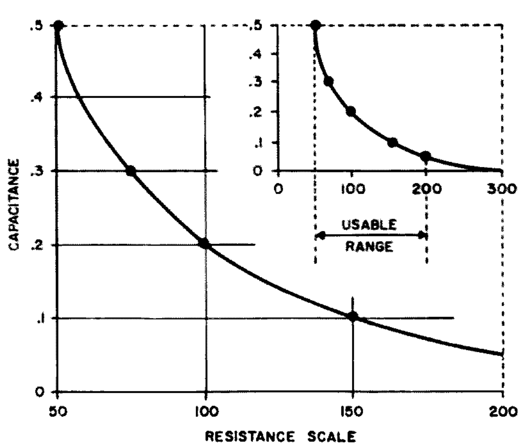
Using two resistors of approximately the same value, attach each resistor to each set of terminals. Find null and record dial reading. Exchange resistors. Find null and record dial reading. Add the readings together and divide by two. The answer should correspond to the midscale reading on the dial. If the answer is not the same, adjust the dial and repeat until satisfactory results are achieved.

Capacitance measuring

You will need three "standard" capacitors, .1 μF, .01 μF, and .001 μF. Label one set of terminals STANDARD. Always attach the standard capacitors to the STANDARD terminals only. Label the other set of terminals UNKNOWN. Using the .1 μF capacitor, attach capacitors of known value to the UNKNOWN terminals. Find the null of each, and record the dial reading. Do this with a wide range of capacities. Graph the data. It should have a form similar to the author's graph. If each of the standard capacitors is exactly ten times greater than the other this one graph can be used with all standard capacitors by moving the decimal point to the appropriate place.
. . . WB6AFN



Schematic of the simple C-R bridge.



Calibration chart for the bridge.

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P. A. F. B., Florida

Down Range—AFETR

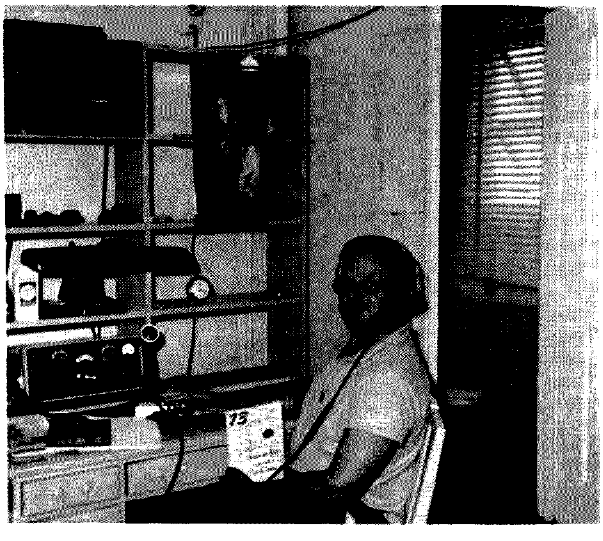
The Air Force Eastern Test Range was established as a testing round for the development of missiles and launching of satellites. Several tracking stations located on islands and ships in the South Atlantic acquire data on missiles and satellites and send this information to Cape Kennedy for analysis.

This data is obtained by telemetry, pulse and CW radar, optics, and receiving soundings. Some data is used to predict an impact point if power should fail in the missile. Some tracking stations are used to generate navigational signals used by ships and planes.

The location of the tracking stations are shown on the map. It is assumed a missile is fired from Cape Kennedy and flies in such a path to take it near the tracking stations.

The prime contractor for the ETR is PAA (Pan American Airways). The sub-contractor is RCA (Radio Corporation of America!).

PAA provides construction and operating of the station. They provide food, maintenance of quarters, laundry, etc.



WA4NXC in his shack. Note the QSL's over the rig.

RCA provides the technical people to operate and maintain the electronic equipment. The equipment is owned by the Air Force and manufactured by several companies.

Items necessary for sustaining human life are supplied by PAA. A military-type dining room is operated and the food is excellent. A typical breakfast consists of several juices and fruits, fried potatoes, eggs any style cooked to order, bacon, ham, toast, cooked cereal, hot cakes, French toast, etc. Take your pick of as much as you want.

Dinner and supper offer several types of meats and vegetables. There is no charge for eating in the mess hall.

Free laundry is provided as well as free movies. Modern films with plenty of good Mr. Magoo and Roadrunner cartoons are shown at dusk at an outdoor movie theater.

In addition to 2 weeks normal vacation per year, Downrangers receive an additional 30 days vacation. Free transportation between the station and Florida is provided.

Salary is attractive, Downrangers receiving an additional 30% to 40% depending on location. The salary is also tax free since the stations are foreign.

Mail service is provided by the Air Force. I count on a mail delivery once a week even though they are planned more often.

Tracking stations are on tropical islands close to the water and boats and fishing gear are supplied.

The working hours are arranged for plenty of time to enjoy the local sports and climate. However, the dining room does not conform. It always wants to serve meals in the middle of a ball game or diving expedition.

Most stations have a club with snack bar where you can buy hamburgers and other snacks. If you prefer to take your meals in

liquid form, attractive prices prevail. For instance—Martini for a quarter!

Getting a license to operate at a Downrange tracking station is not impossible. Inspection of the R. O. I. (Range Operating Instructions) will indicate the procedure for each station. Downrangers can usually obtain a license easier than a native by going through the Air Force.

Out of all the technical people working at the tracking stations, there are very few active hams, one out of two hundred I would say. However, take a commercial vessel that does no technical work, just hauls grain and chemicals around the world, and you will find one out of three or four a ham. For instance, the "Marine Shipper" merchant ship, crew of ten. Out of this are three hams, W4WYI, K2OOR, and W3WVE. Take the RCA missile tracking ship, "American Marriner" 300 scientists and engineers on board, only one active ham, W5CAZ.

On a tracking station near the U. S. fringe area, TV reception is possible from Miami. This brings back the TVI problem. Also BCI, where thirty men live in one building, all playing their transistor radios. All we need is Mr. Ham to fire up a 100 watt rig down the hall and these transistor radios pump up and down with his keying or modulation.

The ham that does operate will use earphones, have his room light out, and use a disguised antenna. Could be there are more hams and they just don't let it be known.

Of these so-called active hams down range, why don't you work them? My investigation shows this:

The typical ham getting off work checks out scuba tanks, does a bit of spear fishing in the crystal-clear, shark-infested waters of the South Atlantic, makes it back for supper, and thoroughly gorges himself.

Then to the club for a few after-dinner drinks to aid digestion. Then it's time for the outdoor movie theater and become food for the mosquitos and sand fleas for three hours. After that some liquid refreshments, game of darts and pool, then bedtime.

Who wants to turn on the rig? Because downrangers have exotic prefixes of VQ9, ZD8, ZD7, etc., it's impossible to have a leisurely QSO with an old friend. The pile up is enough to burn out your receiver.

So you want to join up and operate from exotic DX spots, and really get your fill of DX operating? Chances are you will soon find skin diving, playing pool, and girl chasing in the native village more appealing than sweating over your rig. . . . WA4NXC

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The Second Requirement

Get maximum power from your link coupled transmitter.

Although the pi-network is the most popular output coupling circuit, there are still many who use untuned inductive coupling to transfer power from their transmitter to the antenna. This type of coupling is probably most widely used in portable or mobile equipment where the power is low. It appears to be a simple, inexpensive, and space-saving method but the question arises, "Are you really getting the most from it?" Chances are, you are not!

Recently, I built a battery operated low power transmitter and decided to use this type of coupling.

Fig. 1 illustrates a typical circuit, where R represents the load resistance. Assuming that the antenna and transmission line have been properly matched (in which case R is equal to the line impedance), maximum transfer of power will occur if:

1. The tank circuit (C1 and L1) has a loaded Q of 10 or less,
2. The pick-up or link coil (L2) has a reactance equal to R at the operating frequency, and
3. Coupling is very tight between coils.

Little difficulty arises in meeting the first and third requirements, but if your transmitter fulfills the second requirement, either you are very lucky, or you have taken time to make the worthwhile adjustments!

The object here is to enable you to meet the second requirement! Theoretically, it is possible to compute the approximate inductance, but the approximate is not nearly enough! Most articles state a certain number of turns for L2. This may have been optimum for the author but most likely you will not have a replica of his transmitter. Then too, he may not have adjusted his link properly either.

Trial and error is the method I have found to work most satisfactorily to meet the second requirement. It requires only time and patience. Once finished, you know the status of your power.

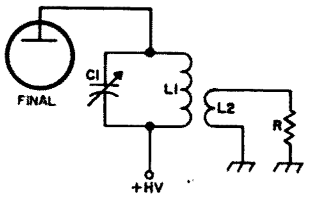

Fig. 1. Typical rf output amplifier showing the output coil, L1, the link, L2, and the load resistor, R.

Following is the procedure I used to increase my output voltage from 0.15 volts peak-to-peak to 13.5 volts peak-to-peak across a 50 ohm load. The dB meter on the receiver went from 35 dB to well past the 100 dB mark!

Since my coaxial cable was about 50 ohms, I connected a 50 ohm, 2 watt resistor directly across the transmitter output connector, keeping the resistor leads as short as possible. The resistor was the composition type and not of the inductive variety. Connecting an oscilloscope across the resistor I found the voltage to be 0.15 volts peak-to-peak with 3 turns on the link of the 40 meter transmitter. The turns in both L1 and L2 were close wound on a 1 inch diameter form. By spreading the turns on L2, the voltage increased to about 3 volts. This indicated that I had lowered the inductance and/or got closer coupling since there was now no space separating L1 and L2. By taking a turn off the link, the voltage increased to about 6 volts for 2 tight wound turns. Opening the turns decreased the voltage. Moving the link closer to, and away from L1 varied the voltage tremendously, although moved only an eighth of an inch or less at a time. Finally, a point was wound where I had a maximum of 13.5 volts peak-to-peak for my little rig and I applied a little cement glue on the pick-up to hold it in place. The results of the adjustment were obvious on the receiver's meter when the rig was reconnected to the antenna line for it pegged!

Many amateurs don't have a scope available as I do, but can possibly find a friend who has one. Pilot lamps of the proper impedance could be used in place of the resistor by observing the brilliance and adjusting for maximum. An AC voltmeter suitable for the frequency might be a substitute for the scope. everal resistors can be paralleled to obtain the wattage and resistance required for your rig. Make sure the leads are as short as physically possible in any case.

After all, if you have given time to build a rig, you shouldn't short-change yourself by keeping the power in the rig rather than the antenna, unless you are in need of a heater rather than a contact! . . . WB2HAL

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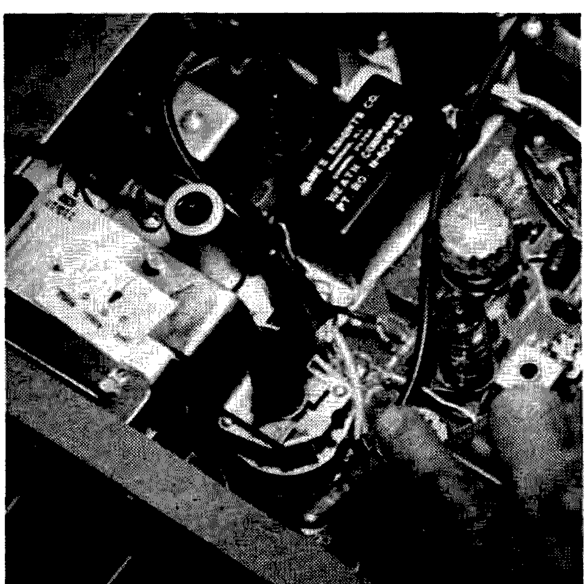
Heath SB400 Modification

The Heath SB400 and SB300 work well together in tranceive but there are times, usually working DX, when it is necessary to operate them apart from each other. It then becomes a chore and takes time to shift plugs and cables in the SB400. The Collins S Line makes a similar change by simply throwing a switch on the front panel of the exciter when the receiver and exciter have been cabled together for tranceive operation. However, at times, this can cause havoc, and pink tickets, should the operator neglect to check the band segment in which the exciter was set. This is what has happened when the CW operator suddenly hears SSB signals from American stations down in the 20 meter CW band. It cannot possibly happen here with the SB400 and SB300 if the following modification is made, because a complete split of the two units has been accomplished by the turn of a switch and they are not interdependent upon one another as in Collins. Furthermore, a messy mix-up of cables is eliminated. The elusive DX station down in the foreign phone band can be heard while he is called, up in the American phone section without delay.



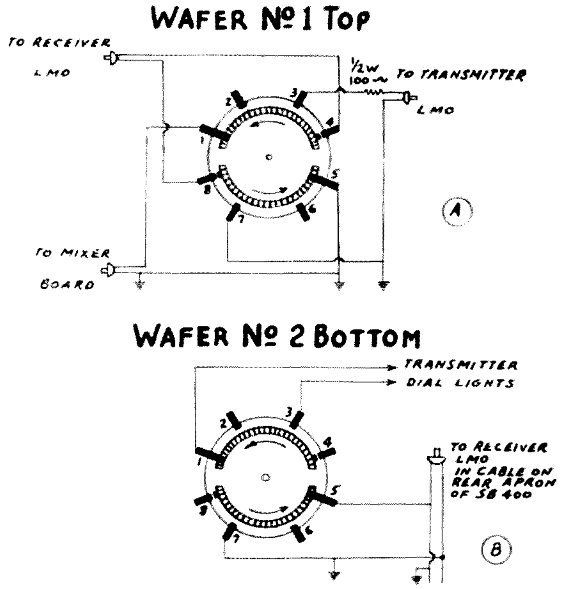
Location of the new switch.

The entire affair is done by the installation of a double throw, 2, 3 or 4 pole rotary switch with two wafers. A common surplus item was used here but others are readily available in the market. The poles of the rotary switch are attached to the lead from the mixer and are thrown to the lead to the receiver LMO or to the lead to the transmitter LMO. At the same time, using the second wafer, when in split operation, the dial lights of the SB400 are energized to indicate that the transmitter is being operated separately and the receiver LMO is grounded out.

This is quite cheap, easy and simple because beside the rotary switch all that is required is a length of RG-58A/U coax, a small piece of aluminum, three phono-plugs, a piece of hookup wire and a 100 ohm ½ watt resistor. Most of the wiring can be done before the rotary switch is installed. The only modification to the original SB400 is a minor change in the wiring of the two dial lights which are fed normally from two different sources. To control them with one switch, the dial lights, of course, must be fed from one source and wired in parallel.

The accompanying photograph clearly shows the placement of the rotary switch for which a small bracket is constructed from the piece of aluminum. The screw which holds the bracket is already in the LMO cover of the SB400. It is loosened and run through a hole or slot in the bracket and put back into its original hole. The bracket is bent sufficiently to permit the rotary switch being used to fit comfortably in the space to the right of the LMO.

The wiring is relatively simple after the cables have been prepared. All of them can be soldered to the rotary switch before installation. Lay aside the two cables which came with the SB400 and which were used to make the transformation to transceive. Save them, as they may come in handy at a later



SHOWN IN TRANSCEIVER POSITION

Fig. 1. Wiring of the new switch for the SB-line.

date. Cut four cables from the RG-58A/U. It is suggested that, prior to cutting the coax, you determine the lengths required by using a piece of solid wire which can be threaded between the components and thereby obtain fairly accurate dimensions. Enough cable should be used to be dressed professionally around the components on the chassis. Length is not critical. In the photograph the cables appear to be rather long; but they were shortened for neatness after the picture was snapped.

Two of the cables just cut are fitted with phono-plugs at one end while the remaining end of each of the two is stripped to solder to the lugs on the rotary switch. One cable, which will go between the rotary switch and the transmitter LMO has the 100 ohm resistor inserted in series with its center lead and a phono-lug is fitted immediately after the resistor. (This is the same arrangement as on one of the original cables which came with the SB400.) The other end is also stripped for attachment to a lug on the rotary switch. The fourth cable is rather long and has both ends stripped. One end of that cable will be soldered to a lug on the second wafer of the rotary switch. The other end will be fed through the rear of the cabinet and joined in and at the phono-plug already on the cable which comes from the receiver LMO. There is a small hole in the back of the SB400 cabinet which requires only a little enlarging to admit RG-58A/U. This concludes the preparation of the cables and they should be soldered to the proper lugs on the rotary switch as set out in **Fig. 1.**

At first glance it will appear as if one segment of the top wafer on the rotary switch is not necessary because all the connections thereto go to ground. However, nothing will be saved by connecting the shields of all the cables together. Nothing but an unwieldy mess results, and there will be saved only one segment of the rotary switch—two sections or wafers are still necessary. The rotary switch, therefore, becomes an excellent tie point for all cable shields.

On the lower wafer of the rotary switch a discerning eye might be led to believe that in place of the long cable which goes out through the rear of the cabinet, connections can be made directly at the rotary switch, thus eliminating the long cable. This was tried and the results were quite unsatisfactory. Spurious emissions appeared. As the purpose of this cable is to ground out the receiver LMO when the transmitter LMO is in use and hereby eliminate or prevent beat notes from the combination of both LMOs, it is logical that the grounding should be made away from the transmitter and outside of the receiver.

As for the dial light modification, view the lights from the front of the SB400. Disconnect the brown lead coming from the base of the mixer band-pass circuit board at the left-hand dial light. Lengthen this wire so that it will reach pin #1 on lower wafer of the rotary switch and solder it to pin #1. (See **Fig. 1B.**) Disconnect all the leads on the right dial light. There are a good number attached thereto because it has been used as a tie point. Solder all those leads together and tape them well. They can hang free. Run a lead from the left dial light to the right dial light. Run another lead from the left dial light to pin #4 on the lower wafer of the rotary switch. You now have placed both lights in parallel from one source of power and the switch will complete the circuit only when it places the transmitter LMO into operation. The connections to the switch can be made after the cables have been attached and before the rotary switch is attached to the bracket on the LMO cover.

To embellish the job you can make a little diagram as seen in the photograph to tell you where the pointer lies. This, of course, is not too necessary because if everything is working correctly your dial lights will light when your transmitter LMO is taking over.

Anyone who has the two pieces of gear can immediately discern the inconvenience which this modification removes. Now, all you have to do to leave transceive operation is to lift the transmitter cabinet cover and switch to split operation!

. . . K4ASU, W4NJF

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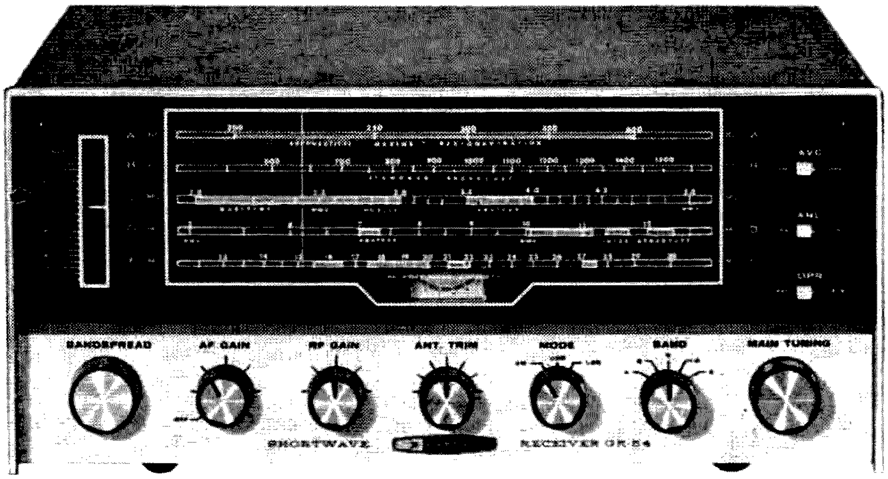
Hagerstown, Md.



Testing the Heath GR 54

Here's an inexpensive general coverage receiver for the ham or SWL.

"Get a $150 SWL Receiver for $84.95," the ad read.

"Well, they'll have to show me," I thought as I sent off a check for the receiver. An ad can and often does say anything, but knowing Heath's reputation I figured I'd get more than $85 worth anyway. After building the receiver, I've found that they're right.

The GR-54 covers 2 to 30 MHz in three bands, plus 180 to 420 kHz and the broadcast band. It contains a power transformer with a full-wave, silicon diode power supply. A tuned rf amplifier stage is used, with two *if* amplifier stages. A diode detector is used for AM detection and a separate product detector for SSB. Two diodes provide the ANL. One stage of audio amplification feeds the output stage. A built-in speaker is provided with an output connection of 8 ohms for external speaker if desired.

A number of multipurpose tubes are used, keeping the count down to six tubes. In addition, six diodes are used, plus the power supply silicon diodes. An "S" meter is used to indicate relative strength of signals. The *if* frequency is 1682 kHz.

Most unique in a receiver (not to mention one under 100 dollars), is the use of two crystals, one at 1680.1 kHz and the other at 1682.4 kHz, providing a half-lattice crystal filter! This crystal filter is placed in the secondary winding of the mixer to first *if* transformer, providing a narrow bandpass through the *if* amplifiers. By using these crystals, selectivity is 3.0 kHz at 6 dB and 7.5 kHz at 20 dB! This is quite remarkable for a low priced receiver.

Sensitivity is very good. Best sensitivity (on SSB), was on the 2.5 to 5 MHz band and was .4 μV average, with lowest sensitivity of 4 μV on the highest band. The relatively low sensitivity on the highest band is rather typical and expected.

I wondered how they could maintain such a high average sensitivity in a kit, with the receiver being built by quite a range of electronic talent. When I built the receiver, this became self-evident. The kit uses five separate, heavy printed circuit boards! As a matter of fact, no wiring is done on the steel chassis, except for inter-board wiring and the power supply.

Three boards are used for the front-end coils. The first one has all of the antenna coils, the second the rf amplifier plate coils and the third the oscillator coils. Even the coils are different on this receiver. They use a very strong coil form with four strong mountings. This prevents the inexperienced from finding it easy to break one of them, or burn them up with a soldering gun.

The rf, oscillator and mixer stages are located on another circuit board, with their associated parts. The last and largest board contains *if* stages, detector, product detector and audio stages. Coaxial cable is used for inter-board connections where required. Layout is good. A long shaft is used with the antenna trimmer capacitor, so that it can be located close to the rf amplifier stage. A rod antenna is used on the broadcast band, acting as antenna and also the antenna coil for that band. The antenna input impedance is a nominal 50 ohms.

Using printed circuit boards for the various coils and circuits, Heath has made alignment very easy. In addition, the coils are pre-tuned, and I do mean *pre-tuned!* I used a lab signal generator to align my kit, and not one of the coil slugs had to be turned more than half a turn. If the kit builder did not have equipment, but followed the directions given in the manual, he couldn't go wrong. (As a matter of fact, I aligned a student's GR-54 by this method and it came off fine.)

Check out of the receiver on the air came off without a hitch. Electrical bandspread is provided, and with the half-lattice filter, selectivity and tuning was very good. The low frequency band (180 to 420 kHz), was somewhat dead at this location, which is normal here. The sensitivity on this band is approximately 1.5 μV, however. The receiver does not have a tendency to overload on strong signals and the antenna trimmer, unlike some receivers checked out here, really makes a difference.

VHF and UHF is of great interest to me, so the receiver was tried out with three different converters for 6, 2 and 1¼ meters, one of which was a tunable type. The receiver is excellent for shortwave listening, and generally ham work, but I think its greatest value to the Amateur is as a fixed or tunable *if* for converters. A receiver used for this purpose must have good stability, sensitivity, selectivity and what is so often lacking, a very stable BFO and product detector for SSB. The GR-54 can deliver this kind of operation, and for this purpose I found it to be great. At $84.95, the GR-54 is a good receiver buy.

. . . W3UZN

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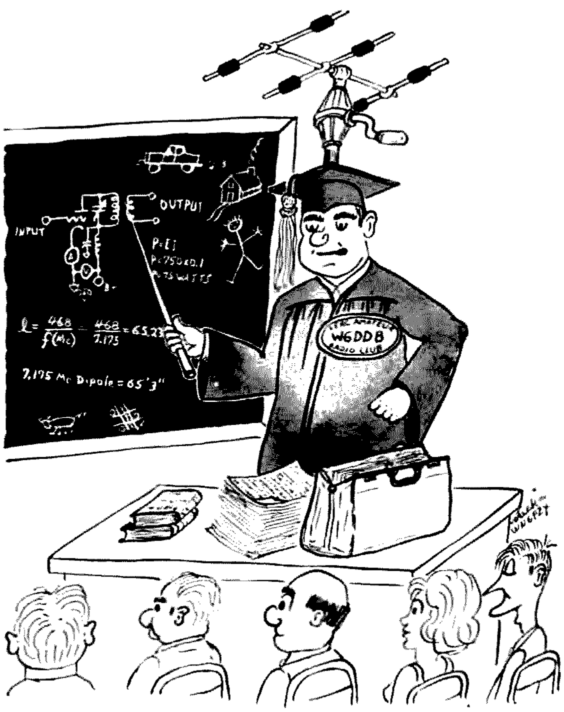
Prescription for Healthy Ham Clubs

Thousands of radio amateurs belong to ham clubs scattered all around the world. Ham clubs are the centers for many interesting and necessary activities which can't be handled efficiently by individual hams. In addition, ham clubs can enable individual hams to enjoy aspects of the amateur radio service which they would otherwise miss. Our ham clubs are becoming increasingly important but their quality is not improving fast enough. This article is intended to help new clubs get started on the right foot and to point out ways established clubs can improve themselves. The author has been very active in several amateur groups and has served as President of the El-Ray (W1OMI), Middlesex (W1HEB), and LERC (W6LS) Amateur Radio Clubs; in addition, he has held key posts in other amateur radio organizations. The same basic questions are asked by those who want to upgrade their clubs and the answers are included in this article. Each category of subject has a heading to make it easier to locate desired material.



A CLUB SHOULD CONDUCT REGULAR LICENSING CLASSES

Board of directors

Purpose: This board determines whether the club will be an asset to the amateur radio service or whether it will be just another mediocre group which stumbles through one boring meeting after another. In short, this board sets the pace and its actions result in a club which is either a failure or a success.

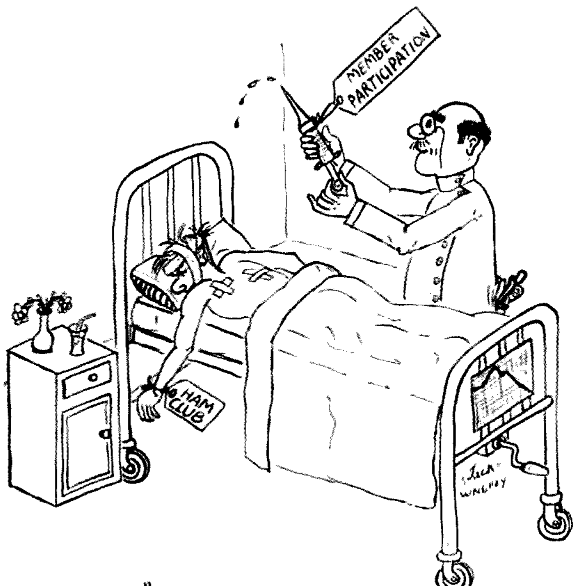
Members: The Chairman of the Board of Directors should be the immediate past president because he is the one person who knows precisely what the objectives of the past administration were. As Chairman, the ex-president can provide desired continuity between administrations to continue long-term efforts toward worthwhile club objectives. If the ex-president is not available, any officer from the previous administration can be elected to chair the board. All officers from the previous administration should be requested to serve on the board along with all the present elected and appointed club officials. Each coordinator (committee chairman) should be invited to serve on the board along with the club's Trustee and Editor (if applicable).

Meeting conduct: The Chairman establishes the agenda prior to each board meeting to make sure that each item will be covered. The board meetings must be started promptly and should be terminated as close as possible to a predetermined regular ending time. The Chairman must conduct board meetings in a pleasant but efficient manner, making sure that each item of business receives no more than its fair share of time and discussion. Board

meetings are not a social affair and board members must be made to realize that board meetings have got to be conducted in a business-like manner. Take care that minor items of business and personal chit-chat do not waste valuable meeting time which should be spent on important club matters.

Business items and motions: Each item of new business should be discussed in detail at a board meeting before it is presented at a regular meeting. All interested parties should be invited to attend board meetings at which items will be discussed which are of prime importance to them. Board meetings must be open to all members and it must be made known that every club member is welcome to attend them, although only the regular board members can vote. Invite interested members to present their views and ideas at board meetings; do not wait for them to ask permission to attend board meetings. The fine details must be hammered out at board meetings before any item is brought up at a regular meeting for discussion and possible action. If a motion will be needed, its wording should be finalized at the board meeting and members should be designated to make and second any such motion. It is ridiculous to waste the time of all club members (at a regular club meeting) on details which are more efficiently handled at a board meeting. If an item of business merits the use of a lot of time at a regular meeting, use it; however, very few items of club business warrant such attention.

Planning regular meetings: All details of each regular meeting are worked out at the board meetings to assure a productive and entertaining regular meeting. Board members should



"A SHOT OF THIS STUFF WILL FIX HIM UP RIGHT AWAY"

include each club coordinator (committee chairman) who spearheads a specific club activity such as:

- Auctions
- Bulletin
- Contests
- Conventions & Hamfests
- Council Federation Activity
- Donation Prizes
- Elections
- Entertainment
- Library
- Membership
- Officer Installations
- Outings & Field Trips
- Publicity & Public Relations
- Refreshments
- Silent Key
- Station Equipment & Operation
- Training Programs
- TVI & BCI

Coordinators: Why go along with the old committee chairman routine when most club functions are actually performed by one person who either does the job himself or coordinates the actions and responsibilities of others to make sure the job is done? Past and present club officers should take on any of these specific coordinator duties which can't be filled by appointees. Most of these coordinator posts should be filled by the President, using members who are prospective club officers.

Selecting Nominees: One of the most important functions of the board is to secure a good selection of capable and willing nominees prior to the nomination meeting. A strong slate is mandatory if the club is to progress and the club's progress is affected by the officers elected. When selecting a slate of nominees, remember that proven willingness to work (plus regular participation in club activities) is more important than technical know-how, operating ability, length of time licensed, speech-making ability, or personal appearance. Desire, long-term interest, and dependability are the prime assets of good officers. It is wise to limit tenure in each elected office to a maximum of two consecutive years to maintain a healthy atmosphere of new blood and fresh ideas in the club. The previous elected officers can strengthen their club greatly by selecting one of the coordinator's posts and concentrating on improving the one facet of the club's activities in which they are most interested. The tenure of club coordinators

should not be limited. Ex-officers are the backbone of the club when they accept appointed posts which are not filled with prospective new officers; this frees the newly-elected officers to do the jobs they were elected to do.

Regular meetings

Conduct: Start and end each meeting on time. Retain a business-like atmosphere until all club business is completed and then ease off and make sure everyone enjoys the entertainment portion of the program. Do not permit time-consuming discussions of business items which should be handled at board meetings. Do not discuss any item of new business until it has been discussed at a board meeting, unless it is of such a nature that there can be no doubt of its ready approval or defeat. The overall conduct of your entire regular club meeting determines whether or not visiting hams will return to future meetings and subsequently decide to join your club. It is easy to get hams to attend a meeting as a visitor but it takes a good meeting (plus a cordial welcome) to get them to return to subsequent meetings. Recognize your visitors without putting them ill-at-ease. It is best to have each visitor seated beside the club member who knows him best and to have your club member rise with your visitor to introduce him. It is a poor practice to have your visitors stand up alone to introduce themselves. Remember that the overall conduct of your regular meetings also determine whether or not you will retain your present members.

Reports: Recognize each officer and coordinator for any reports they may wish to make and allow each to use any rostrum and microphone/amplifier facilities which are available. Make sure you provide regular reports from the Treasurer, Secretary, and Chairman of the Board. If your club publishes a bulletin, such reports can be included in it and they can be routinely accepted at the regular meeting if no member requests any corrections or additions to them. The printed reports give your members a chance to read them as carefully as they desire prior to the regular meeting at which they are to be accepted or amended.

By-laws: Remember that by-laws are just intended to serve as a guide to help expedite the conduct of business in an orderly fashion. Do not allow clubhouse lawyers to tie up a meeting by using the by-laws as a weapon. Have it clearly stated in your by-laws themselves that your presiding officer has the authority to take any reasonable action he deems necessary to assure proper conduct of the

meeting in accordance with the desires of the majority of the members. Make it a practice to give each prospective member a set of up-to-date by-laws at the time you give him a membership application.

Entertainment: Your entertainment program is of prime importance at each regular meeting. Club members have a wide range of interests, experience, equipment, and education. No meeting is likely to satisfy all your members from start to finish but careful planning can produce meetings which cover such a wide scope that all of your members do enjoy some parts of them. Keep training, building, and operating sessions separate from your regular meetings but encourage special sessions for all such specialized purposes. Since your club members do vary so widely in their interests and backgrounds, it is necessary to provide a wide variety of entertainment programs. Occasional short contests (DX prefixes, code runs, FCC rules, TVI, etc.) can add fun and interest to meetings. Use a wide variety of speakers, films, slides, tapes, and displays to appeal to as many members as possible. Vary the entertainment approach often and aim it at a different ham interest group each month.

Use general interest programs on special occasions (such as at the installation of officers) but retain the amateur radio flavor at all times. If your members just want entertainment, they can go to the movies or a sports event—or perhaps just stay home and be mesmerized by the boob-tube. Real hams join amateur radio clubs to participate in worthwhile ham activities.

Excellent films are available from:

USAF Film Library, 8900 S. Broadway, St. Louis, Missouri
Bell Telephone Company (Science series)
Local Civil Defense Groups
Local Army/Navy/Air Force MARS Groups
ARRL Film Library
Local Colleges
Local Lending Libraries
Electronic/Electrical Industries

One or more members can be used to supplement a film or similar light program. Members are often willing to stage an excellent program in conjunction with another program whereas they seldem feel at ease if they are featured as the sole entertainment program.

Each entertainment program should be investigated by the entertainment coordinator and discussed at a board meeting before it is used. Entertainment programming should be shared by as many members as possible to get the benefit of several different viewpoints.

Donation prizes: These prizes can provide a lot of interest at the regular meetings and can help swell the club treasury at the same time. Do not make the mistake of pestering local distributors for free donation prizes. Clubs and individual hams need distributors as much as ham distributors need us and we should do what we can to support local distributors who are making a sincere effort to supply the equipment and components we need. Accept a reasonable discount for club donation prize purchases but pay for everything you get. Try to be impartial and use items from as many distributors as possible.

Major prizes sell most of the donation prize tickets and about 70% of the available donation prize funds should be spent on one major prize. Members purchase tickets with the hope that they will win the big prize. The little prizes don't attract large ticket sales but they do send a few more members home appeased despite the fact that the big one did get away. Plan to retain some fixed amount of the donation prize revenue (10%?) and use the rest to purchase the donation prizes for the next regular meeting. If your members know that 90% of their donation prize money is being spent to purchase donation prizes (at a good discount), they realize they are getting full value for their money and they are willing to put out their cash. It does not pay to be greedy in any club matters and never make the mistake of assuming that your members are unaware of what the score is; there are plenty of lazy club members but darned few stupid ones!

Do not assume that you know the financial circumstances or personal feelings of your members. You'll have members who do not purchase donation prize tickets and they should not be made to feel unwelcome because they don't purchase them. Some people object to gambling even in its mildest forms and you'll very likely have members who honestly do not wish to participate in this club activity. As long as your members know that the small profit from the sale of donation prize tickets is used to support necessary club expenditures, your ticket sales will remain high.

The donation prize coordinator should report results at each board meeting. He should discuss his choice of donation prizes for future meetings. Small prizes can be judiciously selected to meet current club needs and objectives. It is wise to use such small prizes as:

Club QSL Card Orders
Club Dues
73 Subscriptions
QST Subscriptions
CQ Subscriptions.

Rest Break: It is wise to have a 10-15 minute rest break at any convenient mid-point in your meeting. When announcing the rest break, state the time at which the meeting will be reconvened. Prior to the rest break, restate what the donation prizes are for the evening and point out whom members and visitors can approach to purchase donation prize tickets during the rest break. Resume your meeting at the stated time and your members will be more alert and better able to enjoy the remainder of your program. Do not have refreshments available during the rest break.

Coffee Break: Don't hold your coffee break in the middle of your meeting because you rush everyone and cut short discussions which are vital to the club's progress. Hold your coffee break at the end of the meeting when your officers and coordinators will have ample opportunity to complete discussions with other members, speakers, and prospective members.

Rotate coffee break duty among as many members as possible. Provide a fixed maximum amount for refreshments (to your refreshment coordinator) and use a wide variety to get away from the dull monotony of coffee and doughnuts. Mud and sinkers aren't particularly appealing at the end of a long day. Do not allow speakers or visitors to contribute to any refreshment kitty you may have.

Conventions, hamfests, shows

Conducting Conventions and Hamfests: Unless excellent club membership participation is assured, do not attempt to conduct a hamfest or convention. These are major projects which require excellent cooperation from the majority of your members and both can involve large sums of cash which could overtax your treasury. It is wise to participate in local hobby shows and demonstrations whenever possible to keep ham radio in the public eye; this is good public relations.

Advertising your club at radio affairs: Whenever your club members attend conventions, hamfests, radio club council (federation) meetings, meetings of other radio clubs, C-D exercises, etc., have them wear club badges.

Special meetings: It is a good practice to expand your December meeting to include a general interest Christmas Party type program which is aimed at the families of your club members. Several clubs offer their top donation prizes for the year at this meeting and use this meeting to install their newly-elected officers. If your officers are installed at a different time of the year, it is best to hold a formal installation ceremony and to include official recognition for the work accomplished by the out-going officers.

Field trips

Make sure all your members have advance notice of each field trip and that they know whom to contact for additional details. Make every member know he is welcome on all field trips. Conduct field trips to:

- Tower & antenna raisings
- Hamfests & conventions
- Local AM/TV/FM broadcast stations & transmitting sites
- Local radio stations of other radio services
- Member's stations
- Local distributors
- Local manufacturers

Operation

Club station: If you have a permanent site available, set up the best club station your club can afford. Try to have better equipment and antennas than most of your members have themselves. Set up a top-notch Novice station to give your new licensees a taste of the Novice code bands under the best possible conditions.

Use your club station to conduct club nets and to advertise club activities during on-the-air contacts with other active hams. The best place to recruit new members is on the air; who wants hams who don't operate? Make it a practice to have the operators QSL each contact with each station which is worked for the first time. If you print a bulletin, send a recent issue with your club QSL and invite the ham to attend a future meeting, providing him with a couple of specific future meeting dates.

Make it a practice to have the club station operated strictly by the book. Have each operator sign the log book, complete the log in a uniform legal manner, operate in the best possible manner. QSL each QSO, and just plain do the best possible salesmanship job. Remind each member he must have his operator's license with him when he operates any station, including the club station.

Contests: Have your club station active in as many contests as possible, even if it is just token participation. Encourage maximum at-home activity by all your member stations in each contest throughout the year and make special log sheets, check sheets, and reporting forms available for your members. Several clubs offer prizes to their top scorers to encourage increased activity in major national and international contests.

Field day: The annual field day exercise provides an excellent opportunity to test your club's ability to operate under adverse conditions. FD also provides a once-per-year chance to get some excellent public relations work done on behalf of the amateur radio service and your own club. Local newspapers, radio stations, and TV stations are usually glad to provide coverage of your field day activities. If you are sending written articles to newspapers, double or triple space your typed copy and submit it well in advance of the FD date. If you want radio and TV coverage, send them a typed announcement letting them know what FD is, where your group will be operating, and whom they can contact for full particulars. Do not permit untrue or exaggerated statements and stick to known facts at all times. Amateur radio is truly the best radio service and truthful statements of facts are more than enough to remind John Q. Public that we are doing a good job for him. Emphasize the usefulness of the amateur radio service rather than the names and calls of a few club wheels. One's name in print (plus a dime) still just buys one a cup of coffee. Support our amateur radio service and your radio club and forego petty personal agrandizement.

Training

Every club should conduct regular licensing classes to help produce the best possible new operators and to help upgrade present hams. Classes provide an excellent source of new members and your instructors quickly learn which students are the best prospective club members. The newer hams are usually more active than the long-licensed ones and a constant supply of new members (from your classes) insures continued high interest and activity.

Sample examinations & handouts: The author of this article has taught general licensing classes for several years and he's willing to send a sample set of examinations and handouts to any club instructor who requests them. Just send a self-addressed 10 x 12 inch manila envelope and $1.50 in postage stamps and the sample set will be sent as quickly as possible. All clubs are welcome to copy, modify, and duplicate these sheets to use them as they see fit in their licensing classes.

Licensing classes booklet: The ARRL Communications Department has a free brochure available to licensing class instructors in league-affiliated clubs; simply request a copy of "Licensing Classes" to pick up a lot of use-

ful tips on just how one should conduct club classes. This brochure tells you the do's and don't learned the hard way in working with several thousand licensing class students. The training aids, film sources, film contests, hand-out sources, ham manufacturers, code practice stations, typical examinations, etc., are all gathered together in this one booklet to make your job easier and to help make your classes better.

Class conduct: Conduct formal classes and provide your training coordinator with the classroom space, budget, storage area, training aids, and help he needs to run your training program. It is best to keep building programs separate from licensing programs or neither one will prove as successful as it should be. Make extensive use of the excellent films detailed in the "Licensing Classes" brochure.

Code practice: Next to on-the-air contacts, the best way to have your students build up their code speeds is to use pre-recorded tapes. The author of this article has produced a set of seven 1800-foot monaural tape recordings which have been used successfully to take thousands of students from no knowledge of the code up through 13 WPM. A printed break-down of this series of tapes is available to anyone who requests one and sends a self-addressed, stamped envelope. It takes a lot of time and effort to produce good code training tapes but they are extremely effective and you'll quickly agree that it is worth the trouble. A series of seven 1800-foot tapes, recorded monaurally at 3¾ IPS, provide 21 hours of instruction which will do the job.

Extra class course: When the present incentive licensing docket is untangled (and that could be anytime) the higher grade licenses will probably carry operating privileges which will not be available to holders of lower class licenses. Since this is an accepted assumption with most hams, there is a great demand for amateur extra class licensing courses and ham clubs are in the best position to provide the desired training. It is best not to assume knowledge on the part of your applicants; a simple general-class theory test will quickly determine which applicants are qualified to directly enter your extra class course and which ones should be sent through your general course for a refresher before they take your extra class course. If you don't establish a minimum knowledge level for those entering your extra class course, you will be so busy reviewing general class theory that you won't be able to give proper coverage to the advanced theory which should be covered in the extra class course.

Bulletin

Regardless of size, paper, ink, professional appearance, or anything else, a club bulletin is a prime ingredient in any successful club. Your bulletin coordinator (editor) should be provided with a regular budget, reporters, and all the help he needs to get your bulletin out on time. Send each member a bulletin prior to the regular meeting to remind him to attend the meeting. All information should be submitted to the editor (in writing) at least a week prior to the regular printing date. The editor must be kept up-to-date as members are added or dropped and as their addresses and/or call signs change.

Head sheets: Your bulletin head sheets should include:

Club name, address, and call sign
Location, date, and time of your next regular meeting
Name, address, telephone number, and call sign of each officer

Reports and articles: Each club officer, coordinator, and member should be urged to submit full articles and small news items for the bulletin. References to hams and clubs should include their names and call signs. Standard reports from club officers can be printed in the bulletin to preclude the necessity for having them read during regular meetings.

Your editor should print all articles submitted as long as they are not an attack against any person or group. Print items which are of interest to as many of your members as possible. The bulletin must reflect club news and not just be the ramblings and opinions of one member, the editor. Use your bulletin to recognize the effort each member expends on behalf of the club; this is the right place to give credit to those who are doing the work to make your club more successful. Do not print negative comments about any of your members or officers who fail to perform satisfactorily.

Educational articles should be included to help your newcomers and to jog the memory cells of your experienced hams. Get these articles from as many different members and readers as possible. Correct poor spelling but leave the technical content of the writer's article alone.

Articles can be printed which are related to the subject of the coming entertainment program. Such articles give your members a chance to get acquainted with the program

subject and this assures a more attentive audience at the regular meeting.

Your better licensing class handouts often make an appreciated addition to your bulletins. It is a good practice to publish a list of your members names, addresses, call signs, and telephone numbers at least once each year.

Exchange bulletins with other clubs on a swap basis and improve your bulletin by critically comparing it with those you receive. The author of this article would be pleased to exchange club bulletins with any other club.

Encourage club members to send a bulletin to each local ham they contact to help promote prospective new members. Print extra bulletins to be distributed wherever they'll do the most good.

Special club items

QSL cards: Design and print a top-quality distinctive basic club card to be overprinted and used by your club members; print as many as possible to obtain the best possible price. Do not permit variations in the basic card. Take care to produce the best possible card and end up with a QSL which all your members will want to use. Sell cards to members in a wide range of quantities and have the club clear a small profit on each sale.

Badges: Design a unique club badge and urge all members to obtain one and to wear it to all ham activities, especially to your own club meetings.

Membership cards: Design a wallet-size membership card and issue one to each member every year. Some clubs prefer to indicate membership class and longevity of club association on these cards. Honorary members should receive lifetime membership cards plus appropriate certificates, if possible. Each ex-president who completed an elected term in office should be an honorary member.

Supplies: Produce the club membership applications, by-laws, class applications, attendance record forms, class completion certificates, log forms, check sheets, honorary membership certificates, and all other printed matter required for club operation. If the club has a fixed location, store all club materials there and use the club address for all club correspondence.

Money: If your club collects dues, save your treasurer a lot of trouble by making them payable yearly; weekly and monthly dues collections are time-consuming and an unnecessary bother. It takes money to operate a club and you are wasting your time if you're continually forced to operate on a shoe-string and you are faced with constant fund-raising drives. Donation prizes, club QSL sales, magazine/organization subscriptions, initiation fees, refreshment kitties, auctions, dues, and other sources of revenue can all be tapped to pay your club's operating expenses. A moderate initiation fee and reasonably high dues rates are the best way to obtain your basic operating funds. Association with a good club is worth money to a ham so don't be hesitant about requesting the funds you need to operate. If prospective or current members do not feel the club is worth the price to them, let them stay out; just make sure it is actually worth its cost. If special hardship cases arise, initiation fees and dues requirements can easily be waived by your board. Make sure your club is a good investment and your members will pay the tab.

Value: Remember that a club's value is not judged by its total membership, the size of its quarters, or its bank account; many of the best clubs are quite small in these respects. If the club serves the needs of the amateur radio service, the general public, the various levels of government, and its own members, it is an excellent organization.

Silent keys: Each club should establish a silent key committee under the direction of a silent key coordinator. It's the least we can do for a deceased member to make sure his family gets the professional help they need to disassemble his station and to market it at the best possible price.

Summary: Doo-dads such as club decals, jackets, shirts, emblems, stationery, etc. all have proven popular with some clubs. These items are just so much frosting on the cake, though; make sure you bake a good cake before you try to ice it.

It is hoped that this article has provided some new ideas on how to run a ham club. It is understood that clubs must be tailored to meet the specific needs and interests of the members. Some subjects have been mentioned in a few words despite the fact that they are of such great importance that articles could be written on them alone. The purpose of this article is just to hit the high spots and it is hoped that this has been accomplished. Your added suggestions and comments would be appreciated.

Remember that a ham club is supposed to be an association of people who are in the amateur radio service; make sure your club's long-range objective is to be of service.

. . . W6DDB

Inexpensive Key

Marvin McConkey K1MAL

We here at the VA Hospital, Northampton, Massachusetts, have built several Electronic Keyers as described by W4UWA/K3KMO in the June 1962 issue of 73 Magazine as a patient project in our Manual Arts Therapy Radio Clinic. After taxing our pocketbooks to buy a relay and other components not found in our parts box, very little money was left to buy the key. Anxious to go on the air with our radio club call of K1OXT, we decided to

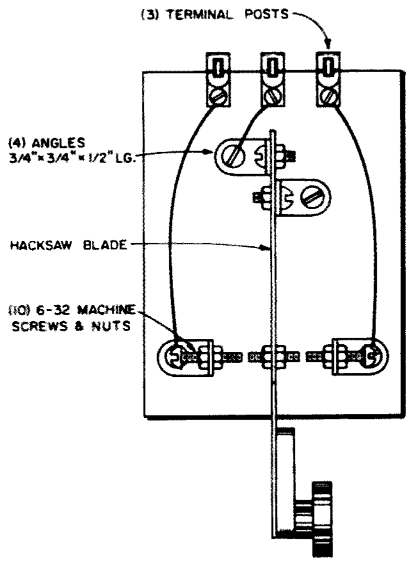
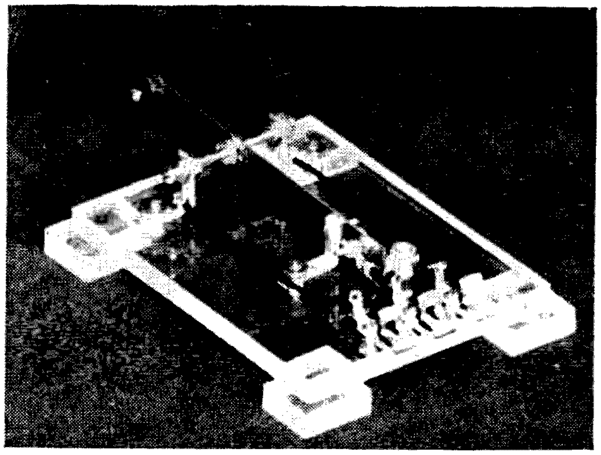


Fig. 1. Inexpensive key knob made from ¼" stock with 1" disc glued to ½" disc and these two discs glued to piece 1" x ⅝". Base is plastic or wood 4¾" x 3½" x ¼".



This photo of the inexpensive key shows the construction.

use Yankee ingenuity and see if we could fabricate a unit. The Instructors in the other Manual Arts Therapy Clinics cooperated and we came up with a couple of hacksaw blades, some 6-32 nuts, machine screws, and a scrap piece of ¼" plexiglass (wood could have been used). We put our heads together back at the Radio Clinic, assembled all these parts and came up with the key. This key has worked out very well for us and we thought we would share the information with your readers and our Amateur Radio Fraternity. This can be fabricated with a very small outlay of cash, a minimum number of tools; such as, a drill, an old hacksaw (hope you don't have to use the blade from the hacksaw which was used for the key arm), and a screw driver.

. . . K1MAL

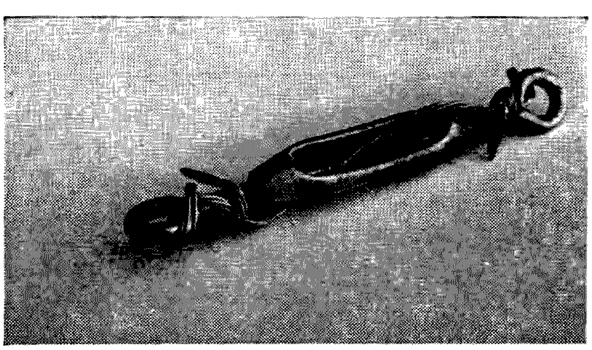
Turnbuckle Safety

Turnbuckles are very commonly used in antenna installations to allow tightening of guy guy wires, and also to provide a break point in the guy when antenna masts are to be lowered. It is not very well known, however, that under certain conditions of vibration in windy weather, that a turnbuckle will unscrew, and therefore open the guy just as destructively as if it had broken!

This is particularly true with new turnbuckles, which have nice, clean, smooth threads.

The use of a nut to lock the threads in the desired position is made difficult by the fact that one half of a turnbuckle uses a left-handed thread, and left-hand nuts are hard to find.

A simple, effective means of preventing a turnbuckle from loosening is shown in the photo. A short piece of common guy wire is fed through the body of the turnbuckle and then through each end, and then twisted to prevent unraveling. This keeps either end from turning with respect to the body. . . . K6UGT

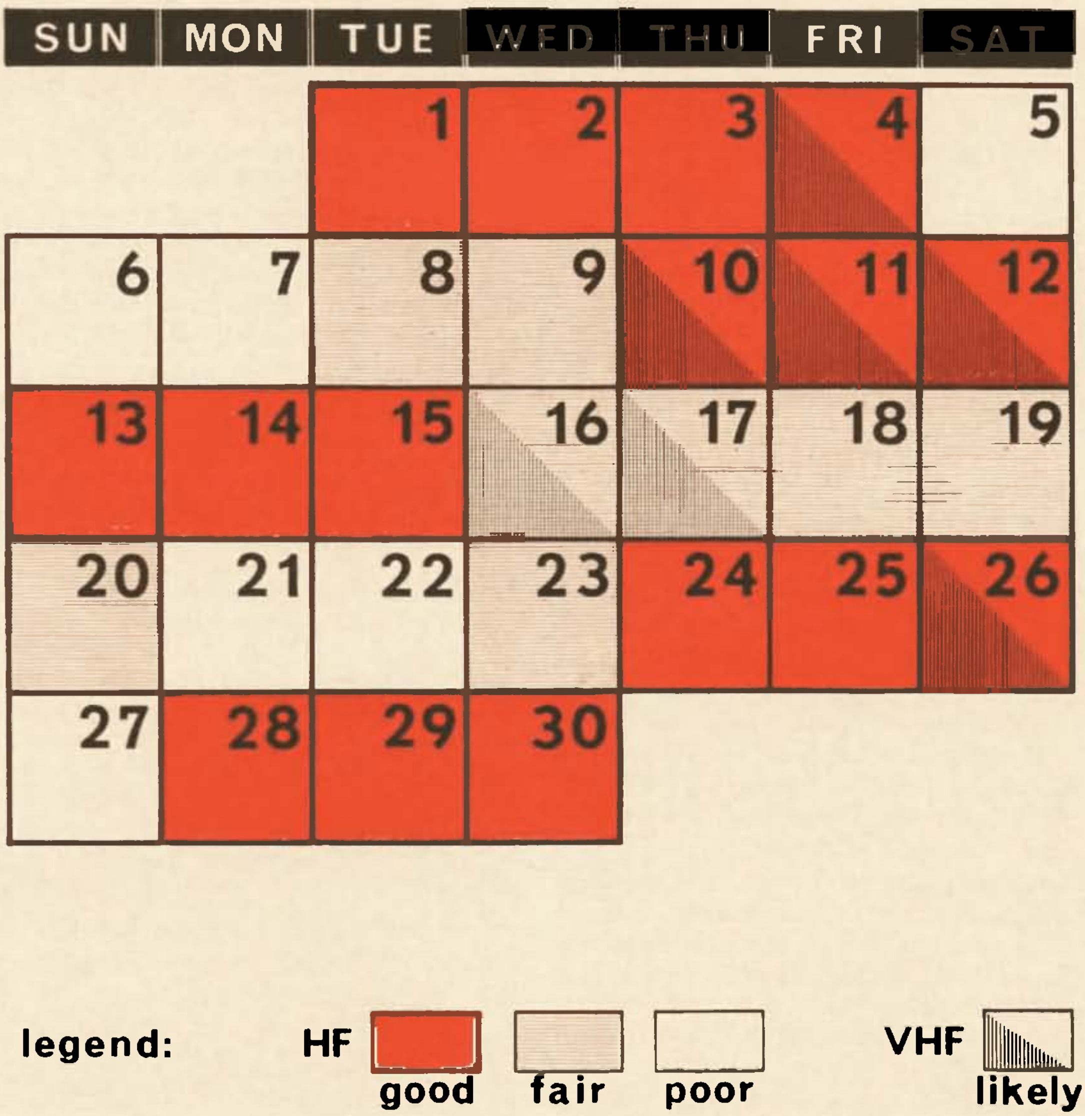


PROPAGATION

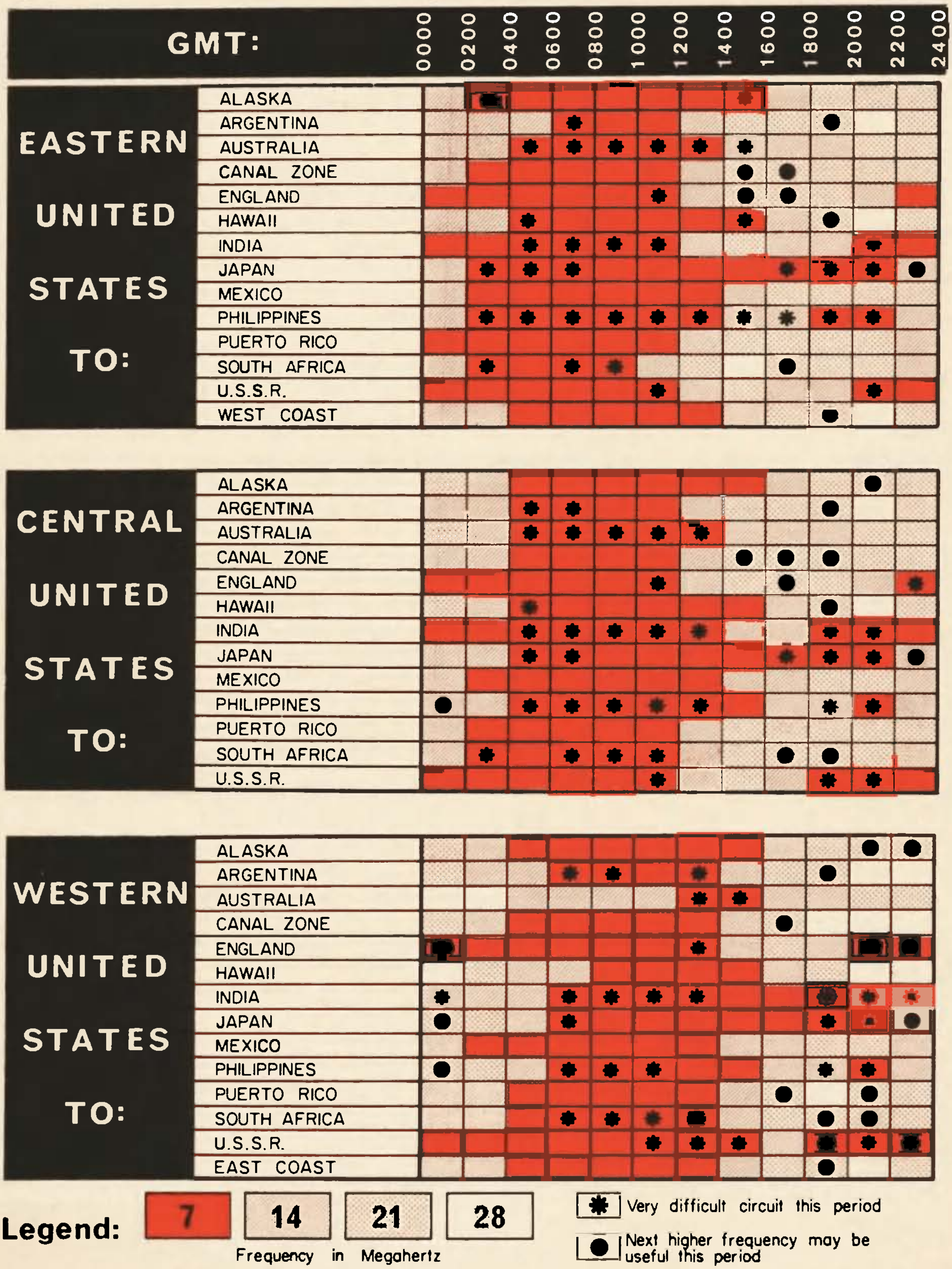
NOVEMBER 1966

J. H. Nelson

DX CALENDAR



OPTIMUM FREQUENCIES HOURLY



Gus: Part 17

Here I was on Mahe, trying to arrange some way to get to some of the rare islands in that general area. I nearly lived down around the docks, cornering any and all ship owners. I had plenty of time to observe the way of life on the Seychelles. These people know how to take it real easy; they don't worry about the various troubles throughout the world; in fact, most of them aren't aware of what's happening beyond Mahe. They are too busy enjoying life to worry about anything else. With the YL population a lot higher than the OM population, the fellows I guess have quite an interesting life. Some of the carrying on that I have heard about would shock some people, I'm sure. The people here do what they want to do, when they want to do it; the least of their worries is what other people think of them. One day as I was operating in my little thatched hut, I saw an old man setting under a coconut tree right out in front of my ham shack. I walked out and had a talk with this old fellow. I asked him where did he work. His answer was, that he did not work at all; I then asked him if he had retired, but he replied he could not retire because he had not ever really worked. About this time three or four porpoises were passing by a few hundred feet out in the ocean; he pointed at them and asked if I ever heard of any fish working. I had to admit I never did. Then he pointed up at some sea gulls and then he asked me if I had ever heard of any bird working; again the answer was no. Then he said to me, "You know God made the birds, and fish, and then made man as His own chosen people. The Good Lord takes care of the birds and fishes, so since man was His own chosen people, I know that God would take care of me." After thinking it over and looking around the Seychelles, I know it's possible for someone to live there a long time and never go hungry. The only clothing you really need is a pair of shorts; you can sleep under a coconut tree on a few leaves or maybe out on the beach. So maybe the old fellow has something there. I still think he was telling the truth about his not ever working. So there you are fellows—scram over to VQ9 land. You'll have it made —but their immigration department says you have to have a reasonable income if you want to stay there. No working allowed!

I even went to a few native dances there, and listened to their home-brew musical instruments. They have a native dance that's very much like the old square dance that we occasionally have in South Carolina. Their version lasts one solid hour. They call out the instructions to their dancers in their native tongue, singing the instructions along with the musicians. This was one time I wished I had along my tape recorder. This would have been something unusual to listen to back here right now.

Things were very cheap when I was there. A good carpenter could be hired for $.25 per day. Now, according to what I hear, the same carpenter wants $.75 per day, if you can get him! This inflation is blamed on the few USA technicians working there on a satellite tracking project! How such a few fellows can bring inflation to an island with about 45,000 population I myself cannot understand.

You soon become a part of the scene and everyone takes you for one of them after a few weeks on Mahe. You are invited out to

dinners almost every night and soon everyone is calling you by your first name. You soon come to know many people there and you begin to see how they enjoy life. I don't think there is anyone on Mahe who has ulcers, unless they had them before they arrived there. The color of the population is anywhere from jet black to blonde, and there seems to be no sign of a color bar there.

After hanging around the docks for a number of weeks, I was invited by a captain of a boat to go with them to what they call Bird Island to gather eggs laid there by various sea birds. When we arrived at the island, which was only a short distance from Mahe, everyone picked up an umbrella before he boarded the small boat that was taking them ashore. I asked the captain if he thought it was going to rain. He looked at the sky and said he did not think there would be any rain from up there, and sort of smiled. I almost got on the boat without an umbrella, but giving it a second thought decided there must be some reason why everyone else was taking an umbrella, so I grabbed one myself, just in case. Away the little boat went for shore. When it arrived on the sandy beach, the sky darkened with squawking birds. I mean the sun actually went out. Then it started to rain, but this rain did not come from any clouds. Back we went to the big boat; we spent the night there and the next day went back. A total of some 900,000 eggs were gathered. Back on Mahe for the next few weeks plenty of eggs were served usually scrambled, and very cheap, too. Usually they are only allowed to gather these eggs during July, and only one trip to the island is allowed. There must have been a several million birds on this island. If you ever go, boys—take your umbrella.

Finally after sticking around the docks all the time I got word that a ship was taking off for the Chagoes Islands. I had been having daily schedules with France, VQ8AM, trying to get a license for the VQ8 islands. It was sort of touch and go regarding issuing a license. When I got word that there was a ship leaving for the Chagoes I immediately got in touch with France, telling him of the situation. He went down this time I think with Leny's brother, Gilbert, who still lives on Mauritius; Gilbert told the head man of their FCC the situation I was in, and he informed them that I should not miss this chance of getting to Chagoes. Telling them that if there was any trouble due to my operation there, he would come to my assistance. The story I got after I finally arrived on Mauritius was

something more or less like that. I got in touch with the owner of Chagoes, and got the all important letter of introduction for me to hand to his island manager in Chagoes. Then I located the owner of the ship that was going there, got his approval to go, then went to the captain and got his approval to go on his ship. I was all set.

I still say I had a perfectly legal right to go there and operate. It was a clean operation as far as I am concerned and even to this day I think it should count as a new one for the fellows that I worked when I was there. Nothing anyone says or tells me will make me change my mind on this operation. Incidentally, I think the same of my BY operation. I wonder how many BY licenses the APRL has ever seen? What proof have they that every BY station is not a pirate? Did Chiang or Mao issue the licenses? If Mao, do they consider this legal? I am under the impression that from the USA viewpoint Chiang is the legal government of China. If the present BY stations are using licenses issued by Mao—are they not pirates from our legal viewpoint? Kinda interesting, all this, eh fellows? I have not ever heard any answers to all this myself. While I am on the subject I am still not 100% sure what is and what is not a country either. Maybe there is no real good answer to this one. I guess there are some good solid rules but there also seems to be so many exceptions to these rules. Russia in their country list says that the Soviet stations down in Antarctica are separate from the rest of them and they call it another country. How about those other countries that are represented down there? Let's not get involved in this country business—it seems to be an endless debate, never quite coming to any definite conclusion. But it is something to think about when you are sitting there tuning your receiver for a new one.

Back to my story again. Here I was with a boat about to depart for Chagoes with only a verbal understanding; the trip was only costing a very small sum of money. I went, since there was no time to monkey around. All the way it was up wind, which meant a lot of tacking back and forth all the way; this added quite a number of days to the trip. Remember, most all boats in these parts are made for sailing, the diesel powered boats are used only to bring others up to the docks and take them away. As usual I did some/MM along the way.

About the third day out, around 10 a.m. one morning, I was operating when all of a sudden one of the deck hands ran into the dining room where I had the equipment mounted on the dining table and grabbed me by the arm saying something and pointing back to where my 14AVS Hy-Gain vertical ground plane antenna was mounted. I ran back with him to see what was wrong. On board a ship I had previously discovered that there usually was not room for all the ground radials, so I would connect a random length of 18 Copperweld to the ground plane and would keep the other end of the wire under the water. To do this, I had picked up from the engine room a bolt about 4 inches long and 1 inch in diameter; this big bolt was fastened to the end of my ground radial and tossed overboard to trail in the water. Incidentally, this makes a FB ground radial and the SWR is very close to 1:1. When I got to the antenna, believe it or not, a fish had swallowed this bolt and was really whipping back and forth in the water. I grabbed the wire and tried to pull the fish in. The Copperweld wire darn near cut thru my hands, so someone handed me a pair of greasy mechanics gloves. This time I managed to pull the fish up to the deck; it was a nice 17 pound tuna, and we ate him for supper that night. We had to cut him wide open to remove the bolt, for it had gone into the stomach of the fish.

Back to the shack I went and began operating. After operating about 30 minutes I noticed the SWR all of a sudden went up (I always operate with the SWR bridge in reflected power position). Out to the antenna I went again, expecting to find the ground wire broken off on account of the swishing back and forth of that tuna fish. As soon as the antenna came in view, I saw what was wrong—a flying fish about 10 inches long had gotten himself wedged in between the 20 meter stub and the rest of the antenna. You know the model 14 AVS Hy-Gain has a 20 meter section running up beside the other part of the antenna; the spacing in mine was about 2½ inches, just the right spacing for this flying fish to get caught between when he tried to fly in between the elements. I called this my "fish catching" antenna, and those two fish were the only ones I have ever accidentally caught in my life. The new 14ASQ Hy-Gain antenna has no 20 meter stub, so the flying fish catching feature is now gone. As fish were needed the deck crew would trail a hook with a piece of meat or fish on it; they always kept fresh fish on hand to eat when needed. A number of large boats passed us on their way to Aden, Mombasa, and tankers to the Persian Gulf; we saw a number of Japanese fishing ships also. Seemed to be plenty of traffic down there—Chagoes next month, boys.

. . . Gus

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Amateur Microwave Propagation

So, you want to go on amateur microwave? Fine! And, you have your equipment built? Excellent! And it tests out fine on the bench? Wonderful! But you can't communicate over a full sized path? Too bad! But don't feel lonesome. Many hams share the same Fresnel zone, to coin a phrase.

Almost without exception, articles dealing with amateur microwave communication have dealt solely with construction of the equipment. Relatively little, if anything, has been said about the path the beam must take in getting from transmitter to receiver. Just because you have a line of sight path does not mean you will be able to communicate via microwave.

Unlike on the amateur high frequency bands, (160-10 meters) where little consideration must be given to the path the signal takes, microwave communication takes something a little more than just putting together a pair of transmitters and receivers. Consideration must be given to such things as

1. Path Loss
2. Transmission Lines
3. Fade Margin
4. FM Improvement Threshold
5. Reflections, Refractions, Diffractions and Fresnel Zones
6. Antenna Gain
7. Antenna Orientation and Polarization
8. Passive Repeaters
9. Path Profiles

Singly, none of the items above are difficult to understand. And collectively they can save a lot of headaches trying to figure *why* a microwave system won't work.

Ray is a transmission engineer. He has thirteen years experience in commercial and military communications.

Path loss

Let's start at the head of the list with Path Loss. This is the calculated *free space* path loss that will occur to the beam going from transmitter to receiver. Path Loss *is not* attenuation (reduction) of signal strength due to the beam encountering any obstacle such as air, dust particles, clouds and the like (although these will cause attenuation). Path Loss *is* the result of the normal spreading of the beam that occurs to all radiations, including light.

In microwave work we must try to approach or achieve free space conditions, since trees, shrubs, buildings and the like can absorb from 12 to 46 dB per mile, or more, of the microwave signal. In most cases this would render microwave communication out of the question.

Free space path loss is easy to compute if you have a basic knowledge of logarithms. If you don't, a high school course in trigonometry with it's associated study of "logs" is recommended. Anyway, to compute path loss, use the following formula:

$$\text{Path Loss in dB} = 36.6 + 20 \log D + 20 \log f_{MHz}$$

where D = distance between antennas in miles,

f_{MHz} = the frequency in megahertz and

Path Loss is expressed as a logarithmic ratio, in dB.

As an example, assume a pair of transmitter/receiver terminals (let's call them a system), are operating on 1215 MHz and the distance between the terminals is 30.0 miles. Then we have a Path Loss equal to

$36.6 + 20 \log 30 + 20 \log 1215 =$

$36.6 + 20 \times 1.477 + 20 \times 3.085 =$

$36.6 + 29.5 + 61.7 = 127.8$ or about 128 dB

So, we have a Path Loss of 128 dB. Of course, if using the formula is too hard, you can al-

ways refer to the nomograph in **Fig. 1** and come just about as close.

Transmission lines

Well, 128 dB is a lot of loss and there is some additional "system loss" in the coaxial cable from transmitter to antenna and from antenna to receiver. For instance, RG-8/U, as used in our hypothetical system, has 3 dB loss for about 30 feet at 1215 MHz. This is the same as cutting your transmitter power in half. So, if you are going to the trouble of getting on microwave, it's recommended you use something better than RG-8/U, such as RG-17/U. It has only 1.3 dB loss at 1215 MHz for 30 feet. Remember, "It costs only a little more to go First Class."

Fade margin

In the design of your system, you will need to consider the degree of reliability you want. This will be a function of your Fade Margin. Fade Margin is the arbitrary signal margin established by the designer and is a function of Reliability. The fade margin establishes the amount of "cushion" you will have to fall back on, in case of a deep fade, before your receiver starts to be controlled by noise rather than signal. To determine your Fade Margin, first decide the amount of reliability you want by referring to **Fig. 3.**

If you have built your equipment, you should know your receiver FM Improvement Threshold (FMIT). If you don't know your FMIT it is easy to calculate.

$$\text{FMIT} = -104 + \text{NF} + \log B_{\text{MHz}}$$

where

-104 = a constant,

NF = receiver noise figure in dB and

B_{MHz} = Receiver *if* bandwidth at the 3 dB points.

In our example, assuming a noise figure of 13 dBm and a bandwidth of 3 MHz, we have an

$$\begin{aligned}\text{FMIT} &= -104 + 13 + 10 \log 3 = \\ &-104 + 13 + 10\,(.4775) = \\ &-91 + 4.775 = \\ &-86.225 \text{ dBm}\end{aligned}$$

Rounding this off we have an FMIT of -86 dBm. This is the knee of the inherent thermal noise characteristic of your receiver, the "crossover" point where internal thermal noise of RF signal strength becomes the controlling factor of receiver usefulness.

Assuming we would like a 20 dB Fade Margin for 99% reliability with our FMIT at -86 dBm, our median received signal must be -66 dBm or more (by more, we mean going in a less negative direction; -65, -64, etc.). To get a signal of -66 dBm we have to

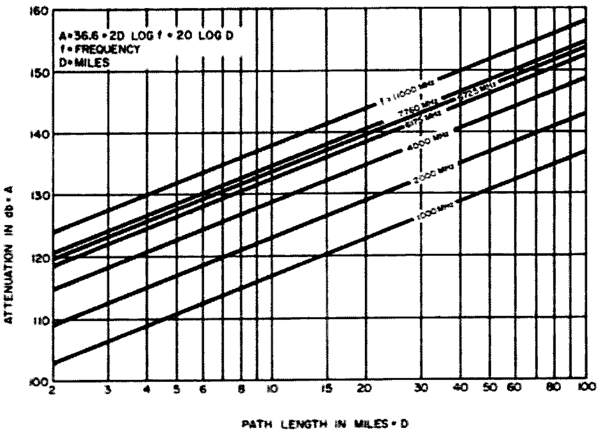


Fig. 1. To determine your path loss at a given frequency, enter the nomograph at the bottom (path length in miles). Assume 30 mile path and 1215 MHz. Read up to frequency of interest. Then read horizontally to the left and read path loss directly in dB (128). Graph courtesy Lenkurt Electric Co.

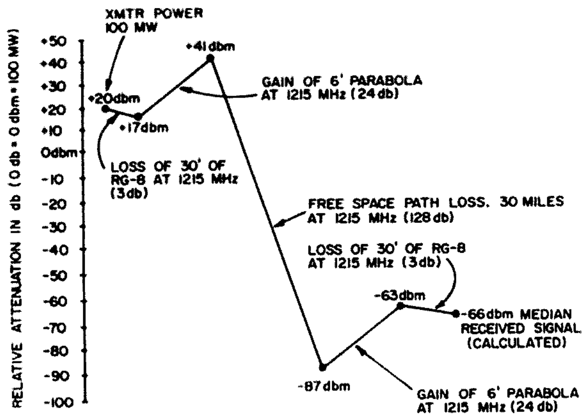


Fig. 2. This figure graphically illustrates the gains and losses in a hypothetical microwave system operating on 1215 MHz. With a 30 mile path, 6 ft. parabolas at each end, a 100 milliwatt transmitter and using RG-8/U transmission line. On the left graph scale, 0 dBm should be shown as 1 mW, not 100 mW.

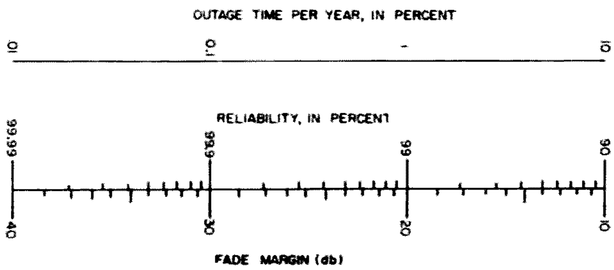
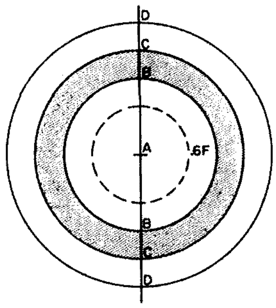


Fig. 3. With this nomograph you can find your percent of reliability of fade margin if you know one of the two. If you want 99% reliability, you must have a fade margin of at least 20 dB. If you have a 20 dB fade margin, you will have 99% reliability. This will give you a total outage time of 1%, less than 3¾ days per year, averaged out to less than 1 minute per day! Courtesy Lenkurt Electric Co.



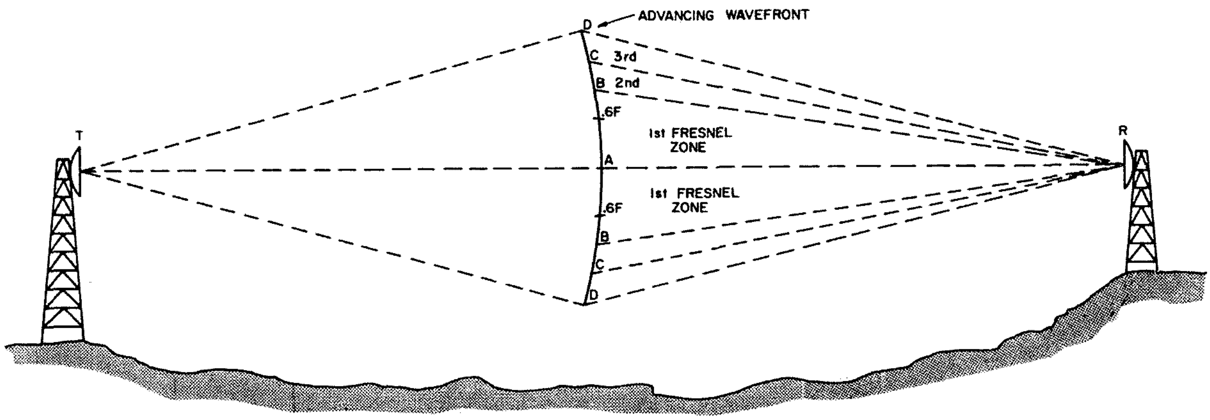


Fig. 4A. Fresnel Zones. Transmitted across space, the microwave beam spreads out, as do all radiations. In this figure the spreading is greatly exaggerated for clarity. At mid path, for a 30 mile path, at 1215 MHz, 6/10 first fresnel zone clearance would be equal to 75.9 feet, with full first fresnel zone radius extending to 126.54 feet.

get rid of 68 dB of our system loss. (System loss is the total of all losses in the system. **Fig. 2** shows that we have 134 dB system loss.) By using a 100 milliwatt transmitter we knock off 20 dB of this 68 dB, leaving 48 dB.

Then by using two 6 foot parabolas with a gain of 24 dB each, we can get rid of the remaining 48. To compute the gain of a given parabola at a specific frequency, use the nomograph in **Fig. 7**, or the formula with it.

With a 20 dB Fade Margin you will have a cushion of 20 dB to fall back on if propagation conditions cause freak fading. A 20 dB cushion will give you 99% reliability which means that in one full year of operation, 24 hours per day, the path will be out a total of less than 3¾ days, spread out over less than an average of 1 minute per day. Try getting that on 20 meters!

Reflections, Refractions, Diffraction and Fresnel Zones.

Much of the fading that will be experienced on microwave frequencies will be during the early morning and evening hours and particularly in spring and fall. Fading on microwave frequencies is frequency selective. That is, when a fade is occurring on one frequency, the likelihood of a fade occurring on an adjacent frequency with the same antenna heights and polarizations and located at the same point, will be very remote. But, if you are worried about reliability and fading you can always operate "frequency diversity," that is with two transmitters and receivers at each end, spaced 20 megahertz or more apart. Another alternate is to operate "space diversity" with two antennas serving one receiver or transmitter and spaced by at least 20 wavelengths. Surprisingly perhaps, fading will occur most frequently in flat areas such as in the wide mountain valleys and in coastal regions. Several good examples of the valleys are those that run North and South through Nevada and California. Some of these valleys are as narrow as 10 miles or so while others may be as wide as 100 miles or more. The Great Plains region, hundreds of miles wide and extending from the Llano Estacado region of West Texas, north to the Canadian Shield is another region having considerable fading. The reason for frequent fading in these areas is that they favor "layering" and columnaring of layers of air at certain times of the day and night, when the air is still and moisture is trapped in columns or layers of different temperature. These inversions cause reflections, refraction and diffraction or ducting of the microwave signal. Unfortunately, these are not readily predictable but they should be of minor consequence to ham operation.

Probably one of the more critical consider-

ations of designing a microwave path is that of the Fresnel Zone. You might rightly ask, "What is a Fresnel Zone"?

Definitively speaking, Fresnel Zones are alternating zones of cancellation and reinforcement caused by interaction of the incident and reflected waves. Even numbered Fresnel Zones are destructive in nature while reinforcement is obtained with odd numbered Fresnel Zone reflections, as can be seen in **Fig. 4B.** There are an infinite number of Fresnel Zones but the first three are the most important since they contain most of the power of the beam. However destructive effects can be observed as high as the 12th Fresnel Zone and more. The First Fresnel Zone is that region of the microwave beam where, if a reflection occurs, the path will be between 0 and ½ wavelength longer than the incident beam. The path of the second Fresnel Zone will be between ½ and 1 wavelength longer and the path of the third Fresnel Zone will be between 1 and 1½ wavelength longer, etc.

Figs. 4A and **4B** show the Fresnel Zones to be a series of concentric circles. If you will imagine an obstruction rising through the beam, there will be a series of reinforcements and cancellations of the beam. Note that in **Fig. 4B,** at the outer limit of the first Fresnel Zone, it is possible to actually get "obstacle gain" of 6 dB from a smooth sphere obstacle such as a round mountain or hill without trees.

With a knife edge diffraction, such as a sharp ridge, gain is still possible, although somewhat reduced. The well designed microwave path should be so designed as to present free space conditions between transmitter and receiver. This condition (where obstruction loss is zero) occurs at approximately .6 first Fresnel Zone as well as at other points.

The radius of the Fresnel Zone may be

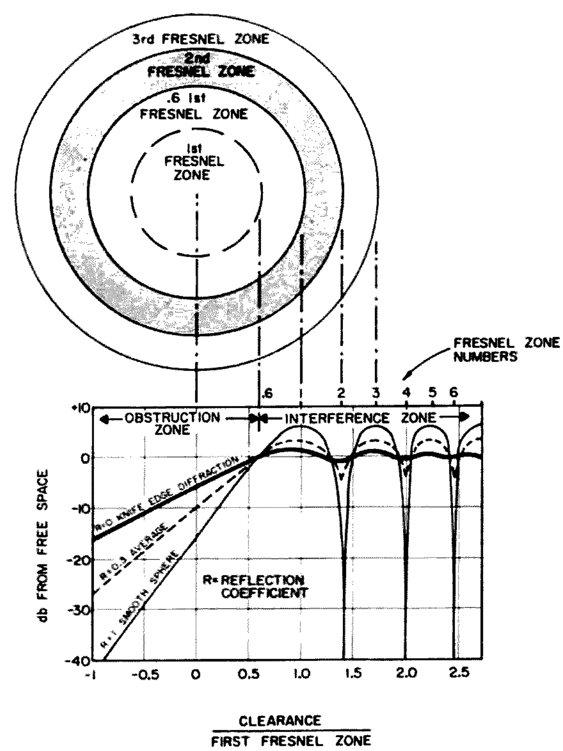


Fig. 4B. This figure shows the curve of the losses attendant to an obstruction rising through the microwave beam. If the obstruction is located so the center of the beam (Point A in 4A) is 75.9 feet (.6 first fresnel zone at 1215 MHz) above the obstruction, the equivalent of free space conditions are obtained and neither loss nor gain occurs. However, if the obstruction is located at the outer extremity of the first fresnel zone so that the very center of the beam is 126.54 feet above the obstruction, "obstacle gain" of 6 dB can occur. This would be the same as going from a 100 milliwatt transmitter to a 400 milliwatt transmitter. By the same token, if the very center of the beam grazes the top of the obstruction, shadowing occurs and obstruction losses will range from 6 dB to 16 dB, depending on the character of the terrain.

Propagation Conditions	Perfect	Ideal	Average	Difficult	Very Difficult
Weather	Standard Atmosphere	No Surface Layers or fog	Some Substandard Light Fog	Surface Layers Ground Fog	Surface Layers Fog Over Water
Location in U.S.A.		Rocky Mtns	Great Plains & East	Coastal	Coastal Water
Propagation Reliability					
60 to 85%			0.6 F K = 4/3	1.0 F K = 4/3	0.6 F K = 1
85 to 98%		0.6 F K = 4/3	1.0 F K = 4/3	0.6 F K = 1	0.3 F K = 2/3
98 to 99.9%	0.6 F K = 4/3	1.0 F K = 4/3	0.6 F K = 1	0.3 F K = 2/3	Grazing K = 1/2
99.9 to 99.99%	1.0 F K = 4/3	0.6 F K = 1	0.3 F K = 2/3	Grazing K = 1/2	Grazing K = 5/12

F = First Fresnel Zone Radius

Fig. 5. This chart gives some characteristic propagation reliability comparisons of various regions with varying propagation conditions and Fresnel Zone clearances for 30 mile paths. Courtesy Lenkurt Electric Co.

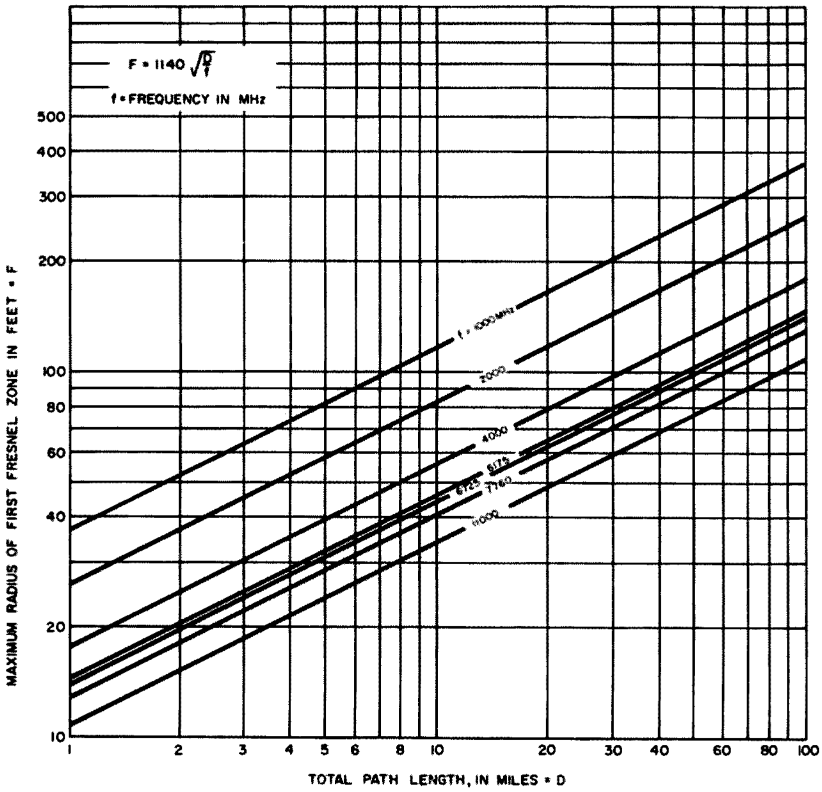


Fig. 6. First Fresnel Zone radius (1 to 11 GHz). To find the radius of the first Fresnel zone, enter the nomograph at the bottom (assuming a midpath of 15 miles and a frequency of 1215 MHz). Read up to the frequency of interest then, horizontally to the left to the radius of the first Fresnel Zone (approximately 125 feet). Courtesy Lenkurt Electric Co.

computed using the following formula:

$$F_n = 2280\sqrt{\frac{n\,d_1\,d_2}{f\,D}}$$

where
F_n = the nth Fresnel Zone being considered,
n = zone number,
f = frequency of operation, in MHz,
D = total path length, in miles,
d_1 = distance from one terminal to the point in question
$d_2 = D - d_1$.

At midpath (where $d_1 = d_2$) the First Fresnel Zone radius is given by

$$F = 1140\sqrt{\frac{D}{f}}$$

where
D = total path length, in miles and
f = frequency of operation in MHz.

For example, the radius of the first Fresnel Zone at 1215 MHz for a path of 30 miles, at midpath =

$$1140\sqrt{\frac{15}{1215}} = 126 \text{ feet}$$

Six-tenths first Fresnel Zone clearance is equal to 75.9 feet. So the center of the microwave beam should be about 76 feet above any obstruction at midpath.

For practical purposes the radius for a given Fresnel Zone can be computed for the middle of the band in question and used with reasonable accuracy at all frequencies in that band. Preparing the path profile as suggested later, you will be able to see any areas that may pose potentially hazardous as far as Fresnel Zones go. And by computing the Fresnel Zone radius and comparing this to the clearance available with the path, frequency and tower heights of the system, you will be able to avoid some potentially serious reflection problems. If you plan microwave work in town, Fresnel Zone reflections can occur from and be computed for tall buildings that have flat sides that make excellent reflecting surfaces at microwave frequencies.

Antenna gain

It's not only of technical interest to be able to determine the size parabola needed for microwave work; it's also of economic interest. Why build or buy a 12 foot parabola when all you need is a 6 foot parabola. And a 6 foot parabola is a lot easier to transport than a 12 foot parabola.

So, we should know how to compute the gain of the various sizes of parabolas available to us.

Two things affect parabolic antenna gain. Frequency and size. The easy way to figure antenna gain is to use the nomograph in **Fig. 7.** If you prefer not to use the nomograph the formula is:

$$\text{Gain} = 20 \log F_{MHz} + 20 \log D - 53$$

where F_{MHz} is the frequency in MHz
and D is the diameter of the parabola in feet

As an example, let us consider a 6 ft. parabola at 1215 MHz.

$$\begin{aligned} \text{Gain} &= 20 \log 1215 + 20 \log 6 - 53 \\ &= 20 \times 3.085 + 20 \times .778 - 53 \\ &= 61.7 + 15.6 - 53 = 24.3 \text{ dB} \end{aligned}$$

Rounded off, 24.3 dB becomes 24 dB gain for a 6 ft. parabola at 1215 MHz.

Antenna orientation and Polarization

As radio waves are reflected from a surface they undergo a change in phase relationship with respect to the receiving antenna. This is dependent on the original polarization and the angle of incidence. Horizontally polarized waves suffer the most change being shifted in phase by about 180°. This in effect changes the electrical path length of the reflected wave by one half wavelength. For horizontally polarized waves, then, if the area of the reflecting surface is large enough to include the total area of any odd numbered Fresnel Zones, the resulting reflections will arrive at the receiving antenna out of phase with the incident wave and cause cancelling interference.

However, vertically polarized waves produce considerable variation in the phase angles reflected. Depending, as with horizontally polarized waves, on the angle of incidence and the reflection coefficient, vertically polarized waves will undergo changes in phase all the way from 0° to 180°. This means that for a given condition of reflection the vertically polarized wave will experience fewer destructive phase changes. So, the conclusion is to use vertical polarization in preference to horizontal, since the vertical is not always subject to 180° phase shifts, as are the horizontal waves.

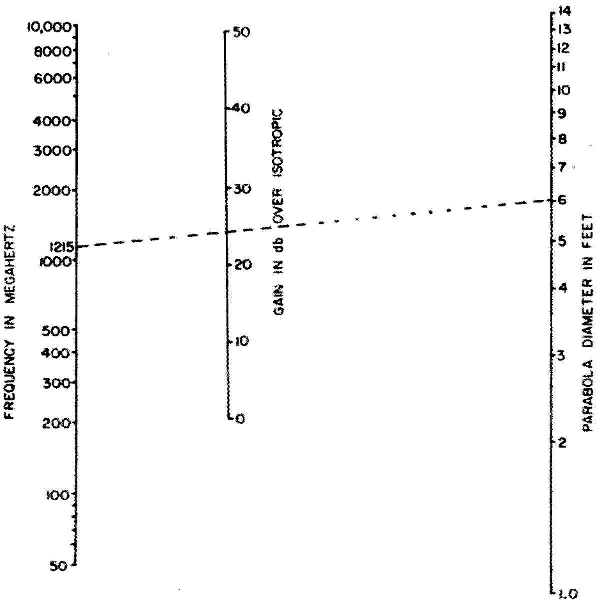


Fig. 7. Gain of parabolic antenna. Connect parabola diameter in feet to frequency with a straightedge. Where the straightedge crosses "gain" line, read gain of the parabola. Or compute by:

Gain (in db) = 20 Log_{10} f — 20 Log_{10} (D-52.6)
where f is the frequency in MHz and D is the diameter of the parabola in feet.

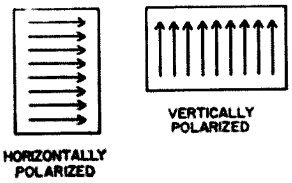


Fig. 8. Electric field polarization. Confusion frequently occurs on the polarization of waveguide and feedhorn openings in microwave work. The electric field is the field of reference and is, mechanically, 90° rotated from the longitudinal axis of the waveguide or feedhorn opening.

If you use waveguide feeds on the higher frequencies, the question of what is vertical and what is horizontal polarization, seems to be a popular one. **Fig. 8** shows the proper polarizations.

Passive Repeaters

If you are going to the trouble of going into microwave work, and on a serious basis, there may come a time that, no matter how high the tower supporting the parabola, a direct workable path may not be available. Then, either a passive or an active repeater becomes necessary. The passive requires no power and can be installed in a remote area, unattended. It effectively has gain, too, and should be considered if signals levels permit.

Commercial passive repeaters are designed so that the face of the reflector is flat within ¾" for 2 GHz[1], ¼" for 6 GHz and ⅛" for 11 GHz. For 1215 MHz ham band operation, a flatness of 1" or so should be satisfactory and this is easily obtainable with a homemade reflector. The reflector must be made of a conductive material. 4' x 8' sheets of ¾" plywood, with the reflecting conductive material (heavy aluminum foil or sheeting) mounted to it makes a good passive reflector for 1215 MHz. A number of these 4 x 8's mounted on a two by four frame work will make a good passive repeater for temporary use.

When computing the path loss of a system using a passive repeater, you must compute path loss between transmitter and the passive

[1] GHz = gigahertz: 1,000,000,000 cycles per second (1 kMc).

and between the passive and the receiver, separately, rather than just between transmitter and receiver. The gain of the passive is the result of intercepting a part of the microwave energy transmitter and concentrating this energy into a narrow beam that is redirected in a concentrated beam toward the receiving antenna. The gain of the passive is found by

$$\text{Passive Gain in dB} = 20 \log \frac{4\pi A \cos \alpha}{\lambda^2}$$

where A is the effective area of the passive in square feet,

λ is the wavelength in feet, and

α is half the included horizontal angle.

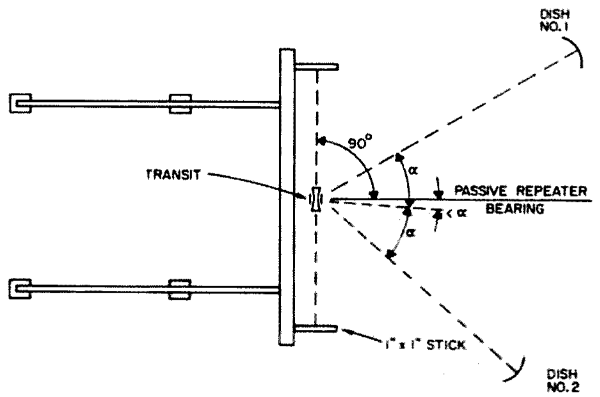
The gain of the passive increases with an increase in area or frequency and with a decrease in the horizontal included angle. The most effective use of a passive is where it is located directly behind and above either the transmitting or receiving terminal location. It's impractical to use horizontal included angles greater than 140 degrees with the flat passive. Beyond that point the effective area becomes small and the passive becomes impractical and uneconomical.

The effective area is equal to the actual area multiplied by the cosine of one half the included angle and if the vertical angle is large, also by the cosine of one half the vertical included angle. Usually the vertical angle is small, only a few degrees, and is neglected.

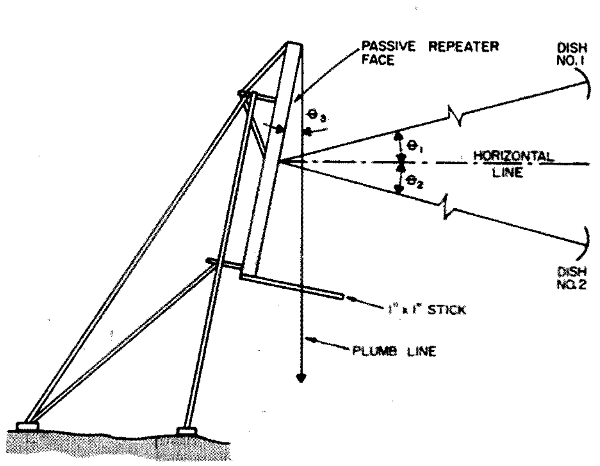
In some cases, two parabolas connected back to back, with a short section of transmission line can make a very useful passive repeater. The transmission line should be kept as short as possible.

Path Profiles

When you have selected your tentative transmitter and receiver sites, a profile chart of the topography of the path should be prepared. With the profile you will be able to see areas that may present potential reflection points. A preferred method of illustrating the path profile is to use the "flat earth" with a curved microwave beam. The degree and direction of the bending of the beam can be defined by the equivalent earth radius factor K and multiplying this by the actual earth radius, R, gives the radius of a fictitious curve equal to the curvature of the earth minus the curvature of the microwave beam. Using the flat earth method you can compute, plot and



PLAN VIEW



SIDE VIEW

Fig. 9. For passive repeater installations, three angles must be measured and two angles must be calculated. The three to be measured are (1) the vertical angle between a horizontal line and the incoming beam, (2) the vertical angle between the horizontal included angle and (3) the horizontal included angle between the two paths. The two angles to be calculated are (1) the vertical face angle of the passive and (2) the correction angle which is added to the bisector of the horizontal angle. The equations are

$$\tan \Delta \alpha = \frac{(\tan \alpha)(\cos \theta - \cos \theta_2)}{(\cos \theta + \cos \theta_2)}$$

and

$$\tan \theta_3 = \frac{(\cos \Delta \alpha)(\sin \theta_1 + \sin \theta_2)}{(\cos \alpha)(\cos \theta_1 + \cos \theta_2)}$$

where

$\Delta\alpha$ = a correction angle added to the bisector of the horizontal angle to rotate the passive bearing toward the path with the least vertical angle,

θ_3 = the vertical face angle of the passive

2α = the horizontal included angle

θ_1 = vertical angle for path 1

θ_2 = vertical angle for path 2 and

(Conventions: sines are positive when the angle slopes downward and positive when the angle slopes up. Cosines and tangents are positive). Courtesy Microflect Co., Salem, Oregon.

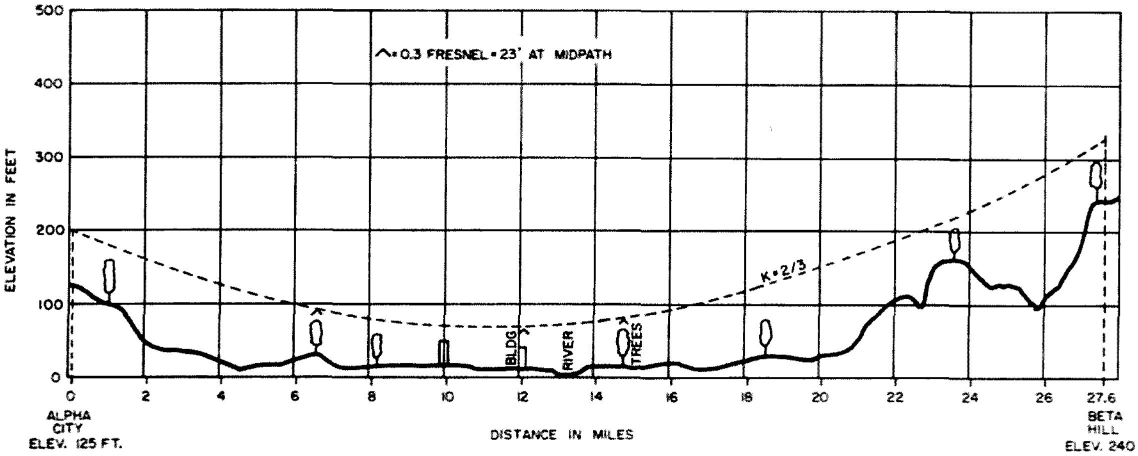


Fig. 10. Representative topographical path profile plotted with a ⅔ earth curvature. Courtesy Lenkurt Electric Co.

investigate the conditions for several values of K, to accommodate a changing propagation medium that might cause reflections. Normal atmospheric conditions prevail when $K = 4/3$.

Typical path clearance data and progagation reliability for a 30 mile path are given in **Fig. 5.**

The curvature for the various values of K at given points along the path may be found by

$$h = \frac{2d_1 d_2}{3K}$$

where

h = the change in the vertical distance from a horizontal reference line, in feet,

d_1 = the distance from a point to one end of the path, in miles,

d_2 = the distance from the same point to the other end of the path, in miles and

K = the equivalent earth radius factor.

Fig. 10 shows a typical path profile using the flat earth method and **Fig. 11** is a nomograph designed to aid in determining the earth curvature for various values of K. When the propagation conditions are normal and $K = 4/3$, h is equal to one half the product of the two distances.

Well, we've come from Path Loss to Path Profile. You may have found some new ideas or some new slants to old ideas all for the purpose of making your microwave work more effective. Many of the considerations may be applied to VHF work as well, such as using two Yagi antennas back to back to make a VHF passive repeater.

Design of a microwave system, whether it contains only two terminals or many repeaters with spur terminals, must ultimately be a balance of all the elements and considerations of the system, including economics, reliability, flexibility and others, to accommodate the transmission of a signal from one terminal to another.

With more and more hams going into microwave spectrum, data such as that presented in this article will become more and more important. As the VHF frequencies become overcrowded in the metropolitan areas, other means will be required to circumvent interference on these bands. The establishment of ham microwave nets and systems across states for CD and emergency communication applications will require more sophisticated design of these future ham microwave systems.

. . . WA6PZR

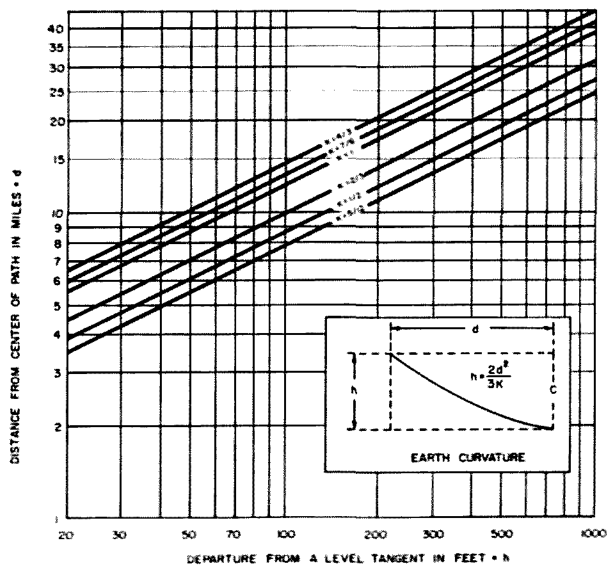


Fig. 11. Plotting the curvature of a microwave beam with a "flat earth" path profile. For a ⅔ earth radius factor, enter the nomograph at the point under investigation, say 10 miles. Read horizontally to the right to the ⅔ curve then read down to 100 feet, which is the departure of the curve from a level tangent to the flat earth. Courtesy Lenkurt Electric Company.

Gus Browning W4BPD
c/o 73 Magazine
Peterborough, N.H. 03458

The WTW DX Award—Progress Report

So far seven stations have qualified for the Worked the World DX Award. All have sent in at least 100 QSL's to qualify. They are: Gay Milius W4NJF (SSB #1), Bob Wagner W5KUC (SSB #2), "Hop" Hopple W3DJZ (SSB #3), Bob Gilson W4CCB (SSB #4), Jim Lawson WA2SFP (SSB #5), Joe Butler K6CAZ (SSB #6) and Vic Ulrich WA2DIG (CW #1). Bob Wagner W5KUC is the first 200 winner with SSB 200 #1.

The big trouble seems to be in getting those QSL cards. A number of fellows I have QSO'ed told me they had worked nearly 200 countries but have yet to receive the first 100 QSLs. Fellows, this is part of the game; but remember, if sending QSL cards is a real hardship on the DX station, they can send us a copy of their log and we will credit every applicant with QSOs that are shown on the log. We have card files for every applicant and it's easy to add to their list. In sending us your score please use standard size (3" by 5") file cards. Be sure your call sign is on each one of them, with your countries listed by their call signs alphabetically and numerically starting with file card number one. For any future tabulations please give us your signal report, number your cards, and be sure to indicate the band and the mode you used. All applications should be for a single band and a single mode; phone and CW may not be mixed or bands mixed. Include $1 or equivalent in IRC's and return postage for the cards.

Do not confuse our W T W award with other DX awards, this is something new, something everyone can enter, even the new comers to DXing. This award gives you a fair chance with the Old Timers; you all start out even. Remember all QSOs have to be on this side of May 1, 1966, 0001 GMT. We are anxiously QRX for some more applicants. In seeking the W T W you will be getting some activity and I am sure that's what we all want. Our bands need a lot of activity to show that we are in need of all the frequencies we have. Waiting for a "new one" in some of the "older" DX awards usually means waiting month after month for something to show up. Why lose all your time just setting around OM when you could be in there working a new one towards your W T W certificate? You fellows that are in the *honor roll* have just about worked yourself out of business and I strongly suggest you get into the W T W and have yourself a lot of fun. The W T W certificate is a real nice one to hang on your wall and will indicate to the boys that you are an *active* DXer. I know some fellows that are in DXCC who have not worked anything new (excepting maybe Don Miller) in the past 6 months. After you have worked those few you still need, what will you do? About all that's left now are places like Tunisia, Iraq, Albania, Sovereign Order of the Knights of Malta, Mount Althos and that's all. While you are QRX for these few that are still left, why not get in on all the fun with the W T W chasers? It will be difficult to get QSL cards for every contact, but at least you are doing something that every DXer likes to do—that's to work DX, even though some of it may be not of the variety known as "rare ones." You can still work those you need that I mentioned above when and *if* they show. You don't have to miss them by being in there getting a few new ones towards your W T W DX award. I admit that lots of fellows are getting tired of chasing DX, trying to work new ones, keeping all the records to know what you need, wanting to throw in the towel on DXing, wanting to see more TV programs such as "Gun Smoke," The Beverly Hillbillys," "Bonanza," wanting to "go fishing," play golf, look at football on TV, and many other things like that. Many of the Old Timers don't want to get up at 3AM to work VR4, VR6, VR3 etc. I myself have been like that the past few months, not because I am tired of working DX, but since I am stuck with a vertical ground plane and a little linear, I am not quite ready for the good, long haul stuff. I will soon have my new antenna up and am building a good linear. Oh yes, I still call myself a DXer, its in my blood. You other fellows I described above are not DXers any longer—you are ex-DXers and may as well face the facts.

The W T W DX Award is for fellows who are still DXers, the ones who like to get in a big pile up and work that rare one. You are

the ones we want in the W T W. The W T W is here to stay fellows, let's face it, its a challenge we admit, but if you are a true DXer you will get with it and have yourself a lot of fun. I hope to see all you true DXers in the next pile up myself, working a few good ones.

Oh yes, my little magazine, "The *DXers* Magazine" is off and running; most of the *Big Guns* and many *Small Guns* are on my subscription list now. It looks good. I think it's filling a needed gap in the DX world, something that's needed and it's not in competition with anyone. Right now it's 16 pages; maybe more later on. . . . Gus

(Continued from page 2)
a single exception, that have led the way in electronics are those who have encouraged amateur radio as a hobby. And, on the other side, that those countries who are presently backward in electronics are, without exception, those that have been indifferent or restrictive to amateur radio.

Thus you can see, far from being just a fun hobby, amateur radio is of the greatest importance to any country. This is obviously recognized in the Soviet where we find amateur radio strongly supported by the government. They know what they are doing. France, on the other hand, has been most restrictive, and it comes as no surprise to us that while the electronics industries of Germany, Russia, Netherlands, England and Denmark are quite well known to us, we are totally unfamiliar with anything originating in France. A visit to France and a bout with their telephone system will tell you more than I can say without fear of reprisal from De Gaulle. France has less than one amateur for every 20,000 of their population (we have one for about 750 in the U.S.) and thus the development of electronics in France is virtually impossible . . . there are no people to draw from . . . they have euchred themselves out of the modern age of electronics by a backward and self-destroying policy toward amateur radio.

In case you think that the French amateurs will be angry with me for using their country as an object lesson, let me hasten to mention that it was they that made a point of this difficulty and they that requested me to bring this trouble to the light of day. France, if it would encourage amateur radio, could have over twenty times as many radio amateurs as it has today and could develop its electronics industry.


Larry Henn 5Z4JW came all the way down from Kitale for the dinner. This is a full day's drive over very rough roads. Larry is quite active on twenty sideband.

So, as you see, there are powerful reasons why amateur radio must be protected and encouraged in the growing countries of Africa and Asia. Our first task is to be sure that the leaders of these countries understand the importance of amateur radio. Our second task is to help them get ham radio started and growing in their countries.

Perhaps what we need at this time in our history is an amateur radio Ambassador to visit these countries and talk with the presidents, prime ministers, kings, etc., and acquaint them with the facts of our hobby and its importance to their country. I haven't tried to see the top men anywhere, so I don't know whether I could do much good along this line or not . . . I suspect that the best I would be able to do would be to see the top communications government official in most countries. I think we need to go higher than this. I think it would take someone like Barry Goldwater or Herb Hoover to get in at the top level.

This is being written in Sydney, Australia and I have no opportunity to call either of these men to find out their reaction to my ideas. I would like to point out though that Herb, as past president of the ARRL, could do amateur radio the best service it has ever had if he could take a bit of that $100,000 the ARRL Directors voted for just this type of purpose and spend it on a visit to see the heads of about twenty or thirty countries.

A lot can be done on the lower levels too, of course. I have been keeping a weather eye open for ways that we can help the growth of amateur radio, particularly among the local amateurs, in these Afro-Asian countries. Let me briefly touch on the situation I found. Kenya: one African amateur at present . . . no licenses being issued. If the license situation could be solved we might be able to encourage things to where we would have a slow but steady growth of African amateurs there, possibly five to ten a year as a starter. Ethiopia: no Africans licensed. Licenses are available and there are a number of Africans that would be interested in amateur radio if only equipment could be made available. The problem here, as in most of these countries, is unbelievable poverty. Sudan: no Africans licensed, no licenses. There are a few Africans ready for licensing if the government comes across . . . equipment is a major drawback here too. Egypt: two active amateurs . . . dozens or more interested, but equipment is prohibitive. Licenses are available. Lebanon: many local amateurs, equipment not difficult to get, licenses are easily available . . . look for continued growth here without much need for

outside help. Syria: one licensee, no new licenses at present due to government problems. They've just had another change of government and it may be a while before they can start licensing again. Iraq is in a similar position. Iran is much stabler and there are several locals licensed and more coming along. Afghanistan has no locals and none in sight. Nepal ditto. Burma is in political turmoil: no ham radio in sight. I'll go into all of these countries and in more detail later.

India is a key country for here we find the largest number of licensed local amateurs, some 400. We now have reciprocal licensing with India, by the way. But 400 out of a population of 400 million is pitifully small even though it is way ahead of all the other Asian countries.

While in India I visited a number of the radio amateurs and had a chance to operate a little from their stations. I got together with many more amateurs and discussed their problems with them. The basic difficulty is poverty. It is difficult for us to understand their type of life. A skilled worker after 10 years at his job makes about $10 a month . . . an upper middle class (comparatively) makes $100 a month. Since there is virtually no radio equipment or parts available in the country the amateurs find it almost impossible to get on the air. One of the most modern pieces of equipment in India is the SX-28, left over from the last war.

The amateurs of India assure me that the only thing holding back more licenses is the lack of equipment. They tell me that they would be able to bring in thousands of men and boys for licenses if only some equipment was available.

That shouldn't be so difficult, now should it? I immediately thought of the mountains of ham gear that are stashed away in cellars, garages, attics, in closets and on shelves that we are no longer using. If some system could be worked out for gathering all this unused equipment and getting it shipped over to India . . . and then if it could be gotten into the country without the usual heavy duty payments and distributed equitably we might accomplish quite a lot. There are a lot of *if's* there. I don't think there will be any great difficulty in surmounting the U.S. end of the deal . . . but what about Indian duty and distribution . . . could these be solved?

I'll go into the blow-by-blow account of how everything was done later on. I did manage to get a verbal agreement from about as high as you can go to permit the entry of gift ham gear and parts into India duty free.

Special visitor at the Nairobi dinner was Ian Cable MP4BBW from Behrein, in town with his new XYL for the day. Ian is on the right. On the left is Steve Gibbs MP4BEQ who is now living in Nairobi and editor of the club bulletin, a surprisingly well-done paper for such a small group. Steve has been unable to manage a 5Z4 license as yet, but perhaps the lid will come off soon and we'll hear him on twenty. Ian is one of the old timers, of course, and anyone who has DXed much knows him well.

And the Institute of Telecommunications Engineers (the Indian counterpart of the IEEE) has volunteered to handle the distribution of equipment. Further, the Amateur Radio Society of India (ARSI) has volunteered to help the program by setting up study courses for the amateur license and classes in technical institutions.

The U.S. end is still open. It would be wonderful if the ARRL would, through its thousands of member clubs, take the responsibility for the collection and shipment of this equipment. If they will not handle this then we must find someone who can . . . I would like to hear from anyone with suggestions.

By helping India . . . and perhaps many other countries, we are helping the world as well as amateur radio. The basic truths that we must get through to the governments of new countries is that amateur radio is vital to the future of their country.

In 1959 India was one of the leading opponents to amateur radio. I believe I've seen a considerable change there and, if we can get gear to help them expand, that we will see an astounding change and find India a firm supporter of amateur radio.

Yes, I think I'm aware of most of the problems involved, if I may answer the usual volunteer group of negative thinkers. I've talked with the head ITE people in India and we have agreed on guidelines for the distribution of equipment and parts. Some will go to

help deserving active amateurs, and a great deal will go for the establishment of amateur radio club projects in schools and institutions. On our end I would like to have the project handled by a non-profit organization so that donations to it can be taken off the income tax, thus helping ourselves a bit while we are helping others.

And please don't write to me about sending equipment or, for that matter, send me equipment for the project. I want you all to know what is going on as it is happening. If you have any suggestions or want to help, this is the time to write.

I believe that the present course of events can be changed. It is encouraging to me that a large number of our ham-owned equipment manufacturers are interested and active in the goal of perserving our hobby. It is unfortunate for us that some of the larger manufacturers seem completely indifferent to our future. It appears as if they view us coldly as a market and nothing more. If we fade away they will turn to other markets. I note, perhaps with perverse satisfaction, that few of these companies are advertising in 73 and that most of them are suffering considerable sales resistance to their products. Further note: though I am aware of the presence of the Bullmoose syndrome (what is good for 73 is good for amateur radio), I try not to let it become too obvious.

Fine, well and good for Wayne Green sticking his nose into things, but where, you ask, does IARU fit into all this? After all, isn't that the only international amateur radio organization? And what about the IARC there in Geneva? Gentlemen, those are two more kettles of fish and, as you have been subtly warned in QST, I have been meddling. I don't want to drag this piece on interminably this month so I'll put this can of worms to rest next month.

Robby 5Z4ERR at his shack in Nairobi, Kenya. Robby has for years been one of the top DX phone operators of the world. Just about every visiting amateur stops in to see Robby at the Robson Chemists shop right in the middle of Nairobi.

Ray 5Z4IR, one of the most active Kenya amateurs now that Robby has sort of "retired" from frantic DX chasing. Ray can be heard many afternoons on twenty rag chewing with his fine signal. Ray is the president of the East Africa amateur club and is shown here with Pete Bailey 5Z4KPB at the dinner held during my visit to Kenya.

So there you have it. I've tried to find out as best I could what is going on and figure out what might be done to improve matters. I'll have more details on my visits to those countries for you adventure fans.

ST2

There are periodic reports in the DX bulletins and columns of activity in the Sudan. Such reports are exaggerated. Back a few months ago ST2BSS was activated for a few days, but this was a special effort and no other activity has been permitted from this country since.

ST2BSS, the Boy Scouts of Sudan station, was set up by Jim Collins, who is in charge of transportation for the U.S. Embassy in Khartoum and is well known for his work in scouting. This station was licensed for operation in conjunction with a special Sudanese scout encampment.

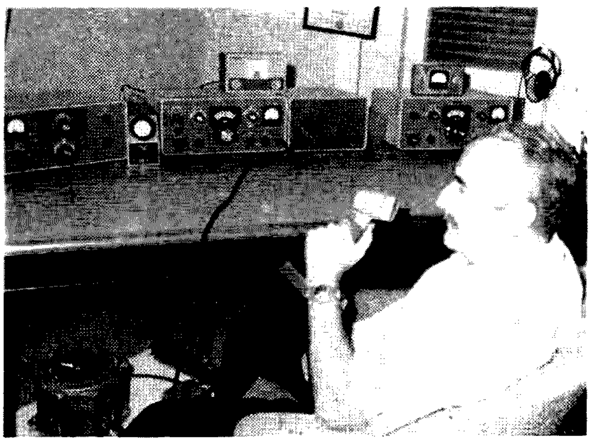
The problem in Sudan is the usual one . . . politics. Just a couple days before my arrival there was another change of government, a coup that was virtually bloodless, with but about 25 lives lost.

Before the coup Jim had been working hard to get ST2BSS back on the air. He was having considerable success too. He had the backing of the Minister of Tourism and the Minister of Communications. All that was needed was the OK from the Minister of the Interior . . . and he had a verbal OK from this office. Then

came the coup and none of the ministers knew what authority they had and no decisions could be made. At this time a subordinate rejected the amateur application with the result that Jim had to start all over again.

I went with him to see the new Minister of Tourism and we found him most enthusiastic about both amateur radio and scouting. He pointed out that, unfortunately, his support was not of much value at the moment because he really didn't know where he fit in the new scheme of things . . . he was sort of up in the air. I was glad to find that he has taken a strong interest in promoting tourism in Sudan and had just received a thorough report on the proposition from an American expert, one that has done much for other African countries. Though there isn't a lot for the tourist to do in Sudan right now, I can see where tourism could be greatly expanded and would be a relatively easy source of outside funds. Nigeria found that each visitor left about $120 behind. Sudan is right on the path from Europe to East Africa and some promotion might get tourists to that part of the world, some 10,000 a year, to stay for a day or so in Khartoum.

Jim's next hurdle was the new Minister of Communications. He tried through friends to set up a meeting with him so I could have a chance to shake hands, but he was busy until after my departure. Just by chance Jim met the Minister at the airport and had an opportunity to have coffee with him and found that he is quite enthusiastic about the scouts and the amateur radio station. The problem then is entirely the Minister of the Interior's department. Jim will be working on this and we may



Jim Collins ST2BSS. Jim is very interested in the boy scout movement and the BSS stands for Boy Scouts Sudan. His great project is to raise enough money to get twelve scouts to the jamboree in the U.S. next August. This would be the first time something like that ever happened, if he can manage it.

In Khartoum I visited Jim Collins ST2BSS, shown here with a copy of some magazine and two of the Sudan boy scouts that he is teaching about amateur radio. When the political situation in Sudan eases and licenses are again possible we will be looking for these two fine lads, Abdul Gayoum Mohammed and Abdul Aziz Awad.

just hear him on 20M one of these days if he succeeds.

The amateurs here have primarily been up against fear of the unknown in the past. The officials did not know much about amateur radio and were suspicious and afraid of it. They have troubles with the Shifta in the south and these forces use radio so their fears have been compounded.

Two of the Sudanese Scouts visited during my stay and I was interested to see that they are well on their way toward their amateur licenses. If the political problems can be overcome I think that, under Jim's tutorship, these scouts will soon be on the air. Jim did a wonderful job of this at his last assignment in Nigeria and is repeating it here.

The Minister of Tourism was quite interested when we pointed out that amateur radio would provide free advertising of Sudan and would encourage tourists to come and see this country. The country is low on money and is eager for any possible income. The income from tourists would be most welcome.

Jim has another project which would help with income to Sudan too. Sudanese scouts have never before been able to go to an international Jamboree. He is hoping that through amateur radio, donations can be received to help pay the way for a dozen Sudanese scouts to the Idaho Jamboree next year. I think that fellows contacting the station would be glad to send along a dollar or two for something like this. I might point out that this would have no bearing on the receipt of a QSL and that the donations would probably be requested to be sent to the Boy Scouts of America in New Brunswick, New Jersey to be held for the Sudanese Scouts.

If the new government holds together there is a good chance that we'll have some ST2's to work. There are a number of amateurs over here, some with gear, just waiting for things to break loose.

SU Report

By a lucky chance I managed to have a talk with Ibrahim SU1IM during my short stay in Cairo. He returned from a vacation just in time for us to get together.

The Callbook lists five amateurs in Egypt. Ibrahim explained that SU1AL is active a little, but on phone only. SU1AS is no longer active. SUIKG is not active. SU1KH has not been well and is inactive. Ibrahim gets on the air two or three hours a day and is the mainstay of this country for the DXers. He runs mostly to CW and gets on AM phone now and then. He runs 100 watts. There is one other chap licensed, but he is out of the country at present. . . . German fellow . . . SU1DL, the only foreigner with a license.

Ibrahim told me about W9DRS sending him his rig. Radio gear is completely impossible for locals to obtain and Jerry apparently got fed up with the rough CW note from SU1IM and shipped him a free rig. Ibrahim had to pay 90 pounds import duty on it . . . this is about $180. And when you consider that the normal wage around here runs about $30 a month you can see that even when the gear is free it is prohibitively expensive.

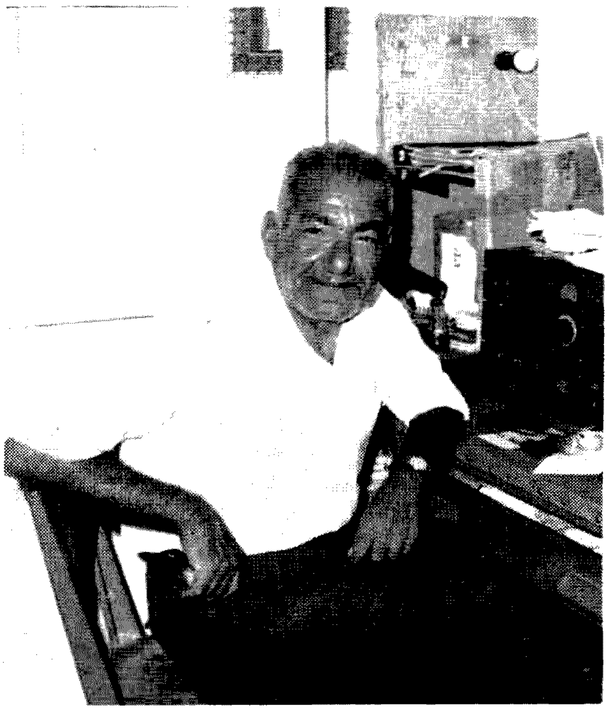
Ibrahim says that equipment is the big problem here. I told him that I could promise a sideband transceiver if he could get the government to permit it to be sent in duty free as a club station. He said he would see what he could do. He knew at least 50 fellows that would be interested in a project like that, if we could work it out.

I went over the list of reasons why Egypt should do everything in its power to encourage amateur radio. Egypt needs radio experienced men very badly and they really can't afford to spend several thousand dollars training each one . . . with ham radio there is no cost to the government for the training. Egypt needs the tourists too and amateur radio is a wonderful and free means of public relations for the country. I pointed out that if Egypt would permit U.S. hams to operate during their visit here that they would get a lot of us to come over. Egypt has everything to gain and absolutely nothing to lose by encouraging amateur radio as much as they can. To

my way of thinking any public official of any government that tried to stop amateur radio is working against his own country and should be immediately removed from office.

Egypt was giving a lot of trouble, particularly with their feud with Israel, but that is calming down now. I wondered why this was and it wasn't until I got here and talked with a chap at my hotel that I got the story. It seems that this high dam at Aswan that Russia is building for Egypt is not all peaches and cream. After it was well along someone got to thinking about it and asked what would happen if some country got mad at Egypt and put a bomb in the middle of the dam some night. Hmmm. The answer is simple, it would wipe out the entire country. You see, Egypt is desert except along the Nile and if the Aswan dam gave way it would send a wall of water about two hundred feet high right on down the river and would wash Cairo and Alexandria right out into the Mediterranean. And that would be the end of Egypt. Since it is only a few minutes by air from Israel to Aswan I think that there have been some serious doubts raised recently about the value of continuing the hassel with them. I know that I would have smiles for everyone if I found myself with something like that hanging over my head.

As if that isn't enough of a problem . . . seems that the engineers didn't think to make a silt survey before building the dam. Now I've seen that Nile down in Khartoum and Addis . . . and points south, and I'll tell you that it is a mighty muddy little creek. It is



Ibrahim SU1TM

CORRECTION

73 goofed in the September and October ads of Unadilla Radiation Products. The price of the all new, vinyl jacketed W2AU 10-15-20 meter element cubical quad should be $64.95, not $54.95 as shown.

dark brown where it starts up in Uganda and it is dark brown all the way along. It looks to me . . . and a number of others . . . as if they are going to have a silt dam there in short order. This not only cruds up the dam, but it has a longer reaching effect on the downstream end. The fields of the fertile valley watered by the Nile depend on the yearly overflow to deposit fresh silt. This is the fertilizer. Without the silt they will have to start buying and shipping in commercial fertilizer. Well, they haven't the money or shipping facilities for this and no one knows what the devil to do about it.

The tourist has some interesting things to see here. The pyramids, of course, are right on the edge of town . . . as is the great Sahara desert. A walk through the town is an experience you'll never forget, morning or evening. The casual tourist can sate himself in one very busy day or two leisurely ones. The more dedicated tourist can get advice from Ibrahim and spend a couple weeks investigating the town. I'm breezing through the world this trip so I quickly saw the pyramids, the Sphynx, a few tombs, rode a donkey, a camel and a horse through the desert. I walked the streets at night and in the day, covering a good deal of the town.

Those of you that are interested in my trip from the tourist angle should keep a weather eye peeled for an announcement of the availability of a complete booklet on my trip. This will cover my trip day by day in ridiculous detail . . . unexpurgated.

With money being as short as it is, QSL's are a problem for the fellows here. The postage on a package of ten cards is 3 piasters, which amounts to about 60¢ if you adjust for the difference in wage scales. Ibrahim mentioned that now and then some kindly fellows sent along a dollar bill, which was most gratefully accepted . . . this is worth about ten dollars here. I explained about the QSL manager system and Ibrahim is most anxious to set someone up as his manager. I'll see if Gus can find a volunteer for this.

Some help is badly needed over here. With a population of about 35 million people they have but three active amateurs. Perhaps we can get something started here. I talked with Ibrahim about the power and it is 180-200 volts at 50 cycles, so, if we can get him set up, a line transformer will be helpful to stabilize the voltage.

The more I travel in Africa the more that I see we can do to help out. Just a little effort on our part could make a big difference over here.

. . . Wayne

Letters

Dear 73:

During 1967, the Canadian Centennial Year, Canadian amateurs may use the prefix 3C- instead of the normal VE-. This is being done to call attention to Canada's Centennial and will undoubtably create a great deal of demand among foreign amateurs for QSL's.

Jack Beardall VE3MJ (3C3MJ)
Chatham, Ontario

Dear Sir:

Please knock off the "hertz" bit. Maybe I'm old fashioned, but cycles seemed so descriptive and to the point. The world is getting too complex the way it is without "hertzes" to contend with. I think that Mr. Hertz was a nice fellow, but don't you think he's satisfied being named after the number one automobile rental agency.

Gotta run and repair my motorhertz now. Keep up the good work.

Ryerson Gewalt K9LCJ
Racine, Wisconsin

Don't forget that "hertz" doesn't mean "cycles." It means "cycles per second." The fact that few people say "cycles per second" indicates that they think that expression is too complex. You ride a motorcycle per second? Ed.

Dear 73:

On WA6BSO's very good cable and connector articles, I might make these comments:

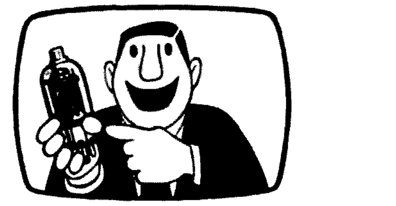
a. Fig. 2 on connectors omits the T, which has a male and two females like UG-107b/u. Mine is marked: 74868 49199 M-358.
b. Odd, but the PL-258 straight adapters I have checked with a signal generator show a loss and swr not present in all the other things hooked in series.
c. Some of the quick jobs are not the first—Hallett during WW11 had a gadget for RG-18 cable with a spring-loaded ring, three steel balls. The inner conductor of the RG-18 became the plug. All you did was push until the three steel balls fell into a slot on the female end. To remove, put hand around it so the knurled ring pulled back to give the three balls room to get out of the slot, and off she came. Trouble: Contacts cut into copper inner conductor, made copper dust that later could accumulate and flash over with 1 kw of low-freq r.e.
d. RG-14 seems to be an attractive antenna cable for hams, but not included as popular.
e. The phono/uhf between-series I have is male phono to female UHF. Not in your photo on page 103. No numbers on it. Very useful without extra gadgets such as connecting antenna pad to signal generator or antenna coax that has male UHF.
f. Fig. 5 terminations may well be very useful at top of tower to go to antenna, etc., but no designations given, not shown in such as Fig. 2 and 3, etc., nor in table 2 which shows binding post but not this termination. I don't know if listed in the long Table 9 on index.

Bill Conklin K6KA
La Canada, Cal.

Dear 73:

Read with interest W2EEY/1's article, "A Curtain Going Up" in the August issue. Nice to see someone pointing out that it's possible to work DX without purchasing some particular brand of rotary beam or vertical, and have him call attention to the advantages of beefing up the lower radiation angles. To recommend 17'4" per element would seem to ignore end-effect and I would rather see a figure of around 16'8", but it's a broad band affair as he points out and I wouldn't quibble over a little inductive reactance. But he should have considered the velocity factor in figuring the phasing lines.

George Dery W6HC
Bellflower, Calif.



NEW PRODUCTS

VHF Antenna Mounts

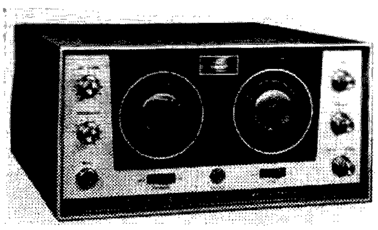
Loren Parks has had some very nice, inexpensive antenna element mounts made up. They're made of iridite-treated Zamac and are very rugged. They hold 3/16 to ⅜ inch elements and mount on 1-¼ or 1-¼ inch booms. Four sets mount four elements and cost only $1 postpaid in the U.S.A. or Canada. Each additional mount is 25¢. Order from Parks Electronics Labs, Route 2, Box 35, Beaverton, Oregon 95118.

New Low-Priced 5-Band Transceiver from National

National Radio Company has just announced the introduction of the National 200, their new five band SSB/AM/CW transceiver features 200 watt PEP SSB input on all bands, 80 through 10 meters, and also provides CW operation plus compatible AM operation with separate AM detection in the receiver. The frequency of operation is determined by means of a pre-mixed crystal-controlled front end and a single VFO which tunes the same range on all five bands. This arrangement provides high stability as well as identical calibration and tuning rate from 80 through 10 meters. Other features of interest in this new transceiver are ALC, a solid state balanced modulator, choice of push-to-talk or front panel controlled operation, automatic carrier insertion in AM and CW modes, filter type sideband generation and receiver selectivity obtained with a high frequency crystal filter and a meter which automatically switches between the final amplifier cathode current on transmit to signal strength in S-units on receive. A mobile mount is included with the National 200 and the unit may be operated from National's NCX-A power supply or from the new National AC-200 117/234 Vac power supply. It may also be operated from any of the available DC supplies which supply the proper voltages and currents. Price: $359.00. For further information and specifications, write to National Radio Company, Inc., Equipment Division, Dept. P, 37 Washington Street, Melrose, Massachusetts 02176.

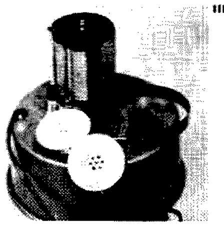
Knight-Kit 20,000 Ohms-Per-Volt VOM

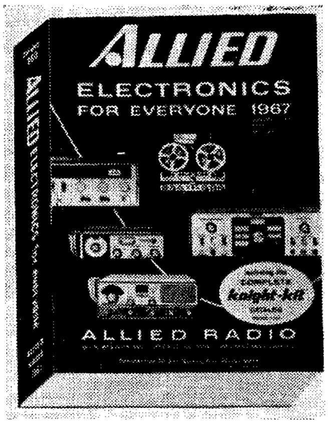
A VOM is probably the most useful of electronics test instruments, and the new Knight-Kit KG-640 is designed for the greatest versatility in application, yet priced to meet the lowest of budgets. The Knight-Kit engineers have included the latest features in this instrument, including a taut-band meter movement which assures reliable and consistent readings. Another advantage with this new VOM, the meter is protected so that even a 1000 times overload will not damage the movement. The KG-640 has a total of 57 ranges starting at 0.8 Vdc (full scale), covered by a positive-action range/function switch and range-doubler switch that effectively doubles the number of ranges. This new unit is priced at $39.95 in kit form, or $59.95 fully assembled and ready to go. Watch for a complete review on this versatile new VOM in a future issue of 73. Complete details on the KG-640 are given in Allied's 1967 catalog number 240, available free from Allied Radio Corporation, 100 N. Western Avenue, Chicago, Illinois 60680.



Lafayette HA-1200 2 Meter Transceiver

The new Lafayette HA-1200 two meter transceiver features a 25 watt DC input transmitter and a sensitive triple conversion receiver with crystal-controlled mixer. The HA-1200 uses 16 tubes, 4 transistors, 7 diodes and utilizes separate receiver and transmitter VFO's. The tuned nuvistor receiver front end provides better than 1μV sensitivity. A series gate noise limiter and squelch provide quiet standby operation. The transmitter uses high level push-pull transformer coupled modulation. The frequency may be controlled with standard 8 MHz crystals or by the VFO. A spot control is included. The meter indicates S units on receive and relative rf output on transmit. Internal solid state power supplies are for 117 Vac and 12 Vdc negative ground. A rugged push-to-talk ceramic microphone with coiled cord, AC and DC power cables, and mobile mounting bracket are included. Size: 11⅞" W x 12¾" D x 5⅞" H. Price is $189.95. You can order or obtain more information from Lafayette, 111 Jericho Turnpike, Syosset, New York 11791.





1967 Allied Catalo

Allied's new 514-page 1967 electronics catalog is now available and presents a wide selection of equipment of interest to the radio amateur. There are transmitters, new single sideband transceivers, VHF equipment for 6 and 2 meters, linear amplifiers, transmitting and receiving antennas, towers, mobile antennas and accessories, code practice aids, crystals, TVI filters, coaxial cable and every kind of accessory for the ham station. In addition to amateur oriented equipment, there are thousands of other products listed in this new catalog, including vacuum tubes, transistors, transformers, relays, switches, connectors, lamps, wire, cable, tools, hardware and technical books. This new 1967 catalog #260 is available free on request from Allied Radio Corporation, 100 N. Western Avenue, Chicago, Illinois 60680.

Low Cost Regulated Power Supply

Viking Engineering of Minneapolis has introduced a low cost transistorized zener reference regulated power supply. Model PZ-121, available in factory assembled or simplified kit form, delivers stable, continuously variable output from 0-15 volts dc and useable currents to 250 mA. This compact, all solid-state unit provides regulation better than ±.2 volts and ac ripple of less than 5 mV for outputs to 100 mA. The PZ-121 features burn-out proof circuitry and transformer isolated output for maximum safety. The price is $13.95 in kit form or $19.95 assembled. For complete information contact Don Springer, National Sales Manager, Viking Engineering of Minneapolis, P.O. Box 9507, Minneapolis, Minnesota 55440.

1967 World Radio Labs Catalog

The new 1967 World Radio Labs Catalog is one of the best catalogs for hams that we have seen in a long, long time. In this new catalog, WRL more than lives up to its motto, "The house that hams built." Whereas many of the new electronic catalogs relegate the amateur equipment to two or three pages in the back, the new 1967 WRL catalog covers ham equipment in great detail. Almost every major amateur radio manufacturer is included between its covers. Entire pages of descriptions and specifications are included for major pieces of equipment of special interest, such as receivers, transceivers and linear amplifiers. Many items of equipment that are not normally found in your local electronics store are also available from WRL. All in all, this catalog offers the largest selection of ham equipment that we have ever seen in an electronics catalog. You may obtain a free copy by writing to World Radio Laboratories, 3415 West Broadway, Council Bluffs, Iowa 51501.

Principles of Electronic Oscillators

Beginning with the definition of an oscillator and ending with review questions of the material covered, the book *Principles of Electronic Oscillators* is definitely aimed at the hobbyist and technician. A logical sequence is followed in presenting the subject material to the reader. Oscillator theory is presented first, to prepare the reader for an explanation of the simplest type of oscillator circuit, the Armstrong oscillator, which is explained in the next section. Biasing and output-coupling techniques follow; and an explanation of the three basic types of oscillator circuits—the Hartley, Colpitts, and electron-coupled—completes the 81 page book. Questions and answers are found interspersed throughout the text, and 32 questions at the end of the book review the reader's newly gained knowledge. This book presents basic oscillator theory which every ham should be familiar with. Available for $1.95 from Techpress, Inc., Brownsburg, Ind. 46112 or your Techpress dealer.

(Continued from page 4)

well as bindings. "They've got a YL column. Why don't you?" "They've got a picture of my station on page 97. Why don't you?"

But I keep remembering a few other facts. 73's circulation has been rising 500 to 1500 per month for over a year, while as far as we know, both of our competitors are still in a decline. 73 is now running more pages of advertising than ever before, while both of the competition are at their lowest points in many years. CQ recently adopted a format of more articles and few columns, with ads spread throughout the magazine, as we've been doing since our first issue in October 1960. QST has made a few small steps in popularizing their format and content (even to using a few bad puns, which are always popular), while I'm sure that all will agree that 73 has tried to be popular and easy-to-read all along. I won't claim that either CQ or QST is copying us, but their changes are certainly in the same direction we've been traveling all along. I can't help wondering why people think we should copy them.

But to get back to the subject, neither binding seems to have overwhelming advantages. We aren't making any plans for changing, but may decide to someday. If you have any comments, we'd be glad to hear them.

Writing for 73

If you'd like a copy of our small booklet, "Writing for 73," which gives information on writing and submitting articles to 73, send us a self-addressed business envelope. We always need new articles and new authors, so don't be discouraged if you're inexperienced.

Ham Helpers

So far eight well-qualified hams have written in to offer to help newcomers or other hams with their problems. We've still got some details to straighten out, but expect to publish a list of the Ham Helpers next month.

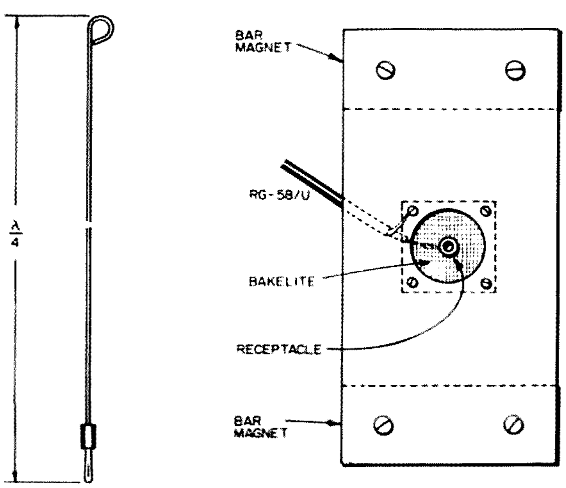
In addition to their direct help, we hope to publish a number of articles devoted to the questions most asked. These questions will probably be grouped by topic: "Questions Often Asked About Novice Receivers," ". . . Transmitters," ". . . Antennas," etc.

If you're qualified to help other hams, and have a little extra time to devote to helping them with their questions, we'd like to hear from you. Why not write today?

. . . Paul

Magnets and Coat Hangers on 2 Meters

Recently, I purchased a Heathkit "Twoer" and decided to go mobile. Because I do not own my own car, the problem of finding a suitable antenna came up. The antenna which I decided on was a quarter wave vertical whip, mounted on a piece of aluminum. Magnets are attached to the bottom which make the antenna temporary.



. . . K9ZPZ

Fig. 1. Temporary two meter mobile antenna.

The vertical whip is made out of coat hanger wire cut for the specific frequency I wished to operate. The "Twoer" is crystal controlled, and therefore I needed only to cut the antenna for the crystal frequency. The top of the antenna is bent into a loop and the bottom is soldered into a banana plug, as shown in **Fig. 1.**

The aluminum, which measured 3 inches by 6 inches, was punched with an inch diameter hole in the center. Bakelite, slightly bigger than the hole, was mounted completely covering the hole. Next two magnets were bolted to the aluminum, and covered with electrical tape to prevent scratching the top of the car.

In the center of the bakelite I mounted a banana plug receptacle. The center of the feed line was attached to the banana plug receptacle and the aluminum served as ground.

If you plan on working two or more different frequencies, different length whips can be cut. In each case solder a banana plug on the end and changing frequencies may be very easily accomplished.

The vertical whip antenna worked very well and will not fall in a strong wind. Its total cost is low and it is an excellent antenna for temporary mobile operation.

. . . Thomas Davis K8DOC

Caveat Emptor?

★ Price—$2 per 25 words for non-commercial ads; $5 per 25 words for business ventures. No display ads or agency discount. Include your check with order.

★ Type copy. Phrase and punctuate exactly as you wish it to appear. No all-capital ads.

★ We will be the judge of suitability of ads. Our responsibility for errors extends only to printing a correct ad in a later issue.

★ For $1 extra we can maintain a reply box for you.

★ We cannot check into each advertiser, so Caveat Emptor . . .

WOULD YOU BELIEVE an NC-303 excellent condition with all National VHF converters in matching cabinet for $265. W5KPE, Rt. 9, Box 391, Tyler, Texas.

AMECO 6 & 2 M TRANSMITTER, never used, with relay, $110. I will pay shipping. Sacrificing to go SSB. Ron Anderson, 22 Ortalon Avenue, Santa Cruz, Calif. 95060.

ALL AROUND OM/YL wanted: Small telephone company, live in very rural Western Utah (terrific DX). Lousy starting salary, but possible draft deferment. Can lead to management with part ownership. Silver Beehive Telephone Company, Grouse Creek, Utah 84313.

QSL CARDS????? Samples 25¢, deluxe 35¢. Sakkers, W8DED, Holland, Mich. 49423.

COLLINS 30S-1 2 KW PEP linear amplifier. Mint condition. Highest bidder pickup here. Bids close 2 December 1966. Certified check $50 must accompany each bid. Money refunded if bid unsuccessful. WA2FMC, 516-AN5-6137.

TELREX TRIBANDER 10-15-20 antenna fraction present cost. Available for $165.00. Ham M Rotator $70.00. Both $225.00. Drake 1000 LP filter $12.00. 300' RG-9/U $15.00 new. Dow Key Relay $10.00. Ameco PV50 preamp $10.00. Two each 416B's $15.00. Two each 4X150's Navy pullouts $10.00. WA2FMC, 516-AN5-6137.

NEW GASOLINE 5 HP 1500 watt generator on pneumatic tired dolly fits in trunk of car $225.00. 3500 watt gasoline power plant $350.00 with electric start system. Pickup and carry. WA2FMC, 516-AN5-6137.

SR150 Hallicrafters transceiver and power supply (AC). Like new, cash price $395.00. W. K. Kern K9BEH, 1808 12th Street, Bedford, Ind. 47421.

DRAKE 2B, mint $180.00; Globe King 400B $125.00; Handbook keyer $15; Collins F250A85 filter, $10.00; IP-69C panadapter, new $20.00; K6ILM, 835 Valencia, San Francisco, 415-282-3201.

HALLICRAFTERS SX-146, HT-46 demonstrators, factory warranty $449.00. Johnson 500 reconditioned $275.00. Eldico SSB-100 MIL $189.00. Write for complete listing. Burghardt Radio Supply, Inc., Box 37, Watertown, S.D. 57201.

SB34, new with mike, Hustler antenna, 80, 40, 20 coils, $295.00. R. C. Dale K1UDI, 86 Westgate Road, Wellesley, Mass.

INVESTOR WANTED to promote the new and unique Bar'B Wire antenna, notify LeRoy Kerr WA6CTK, P.O. Box 444, Montebello, Cal. or page me at OX-4093.

KWS-1 serial number 238, two new final tubes (spares) $695.00. 75A4 serial number 2917, three filters, vernier knob $400.00. Ranger I $65, T60 $35, T50 and VFO $35, Poly-Comm 62B $175.00, NC98 $60, NCX3 with AC, DC supplies $325.00, new 304TL's $15.00, 4CX1000 with socket used $50. Jack Osbourne, 5636 Delmonte Ct., Santa Rosa, Calif.

SIGNAL CORPS and other technical manuals. World's largest list 10¢. Surplus schematics available at 50¢ each. Stamp for list. Quaker Electronics, P.O. Box 215, Hunlock Creek, Pa. 18621.

WANTED: Broken antenna rotators. State price, condition, and manufacturer in first letter. WA6BSO/1, RR #1, Box 138, Rindge, NH 03461.

WANTED: 28 volt prop pitch motors. State price and condition in first letter. WA6BSO/1, RR #1, Box 138, Rindge, NH 03461.

C. FRITZ QSL'S. World famous and of highest quality consistently for over 30 years. Samples 25¢ (deductible). Box 1684, Scottsdale, Arizona 85252 (Formerly Joliet, Illinois).

ESTATE SALE and bargain list. Send for it and include SASE. Write Paradd Sales and Engineering Service, 280 Route 10, Dover, N.J. 07801.

EXCESS GEAR and parts, vacuum variables, variable coils, tubes, meters, transformers, 2 kW linear, diodes (HV), etc. Stamp for complete list. W6MCS, Rt. 1, Box 666, Arroyo Grande, Cal.

RTTY GEAR FOR SALE. List issued monthly. 88 or 44 mH toroids five for $1.75 postpaid. Elliot Buchanan, W6VPC, 1067 Mandana Blvd., Oakland, California 94610.

HALLICRAFTERS SX101A RECEIVER. New condition. No modifications. First $215 takes it. R. Stephens W2NTZ, 3048 Wilson Avenue, Bronx, N.Y. 10469.

SPAULDING SPECIAL tilt-over ham tower. HDTX, 54 feet. 4" and 5" vertical support pipes, also antenna drive pipe, 1¼" included. Never used or assembled. Stephan J. Bage W8DQW, 2099 W. 81 St., Cleveland, Ohio 44102.

FREE 20 WORD classified ad with year's subscription to Ham's Market Newspaper. 12 big issues for only $2.00, or send QSL or post card for sample copy. Box 13934, Atlanta, Georgia.

NOVICE CRYSTALS 80-40 $1.05 each. Also other freqs. Free list. Nat Stinnette W4AYV, Umatilla, Fla. 32784.

WANTED: Military, Commercial, SURPLUS . . . Airborne, Ground, Transmitters, Receivers, Testers, Accessories. Especially Collins. We Pay Freight and Cash. RITCO ELECTRONICS, Box 156, Annandale, Virginia (703) 560-5480 COLLECT.

CRYSTAL CONTROL ON 2304 MHz: AN/FRC-37 (XN-1) transmitter and receiver. Transmitter crystal controlled with 64 MHz-range crystal. 1970-2400 output. Straight through 3CX100A5 final. Completely metered. Video modulator (can be used for voice) included. Uses 5 2C39's. Big blower. Type N output. Receiver: 1700-2400 MHz tunable with excellent AFC. Completely metered. Low noise if preamplifier. Calibrated mixer and preselector tuning. Includes Frequency Standards FSC-174 1675-2425 MHz wavemeter, serial 3001. Both are rack mounted and include cables and power supplies. Operate on 110 V ac. Heavy. Tentative price $200. Paul Franson WA1CCH, Editor, 73 Magazine, Peterborough, N.H.

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AN/ARR-15—Collins 51H3 Radio Receiver has built in 10 channel auto tune system. Can be manually controlled. Freq. range 1.5 to 18 mc am & CW (tunable) 6 bands. Power input 24 VDC at 2 amps 14 tube circuit. $59.50

TS-452C FM Sweep Generator portable unit used in test alignment of IF and RF circuits also experimental or production testing. 50 to 1600 cycles, 1 phase AC. Freq. range 5 to 100 mc in 6 bands (rf output); 5 to 102 mc in 4 bands (freq. meter) type of emission FM $175.00

TS-186/UP Frequency Meter; portable, crystal controlled heterodyne type used in measuring the freq. of transmitters, oscillators, and signal generators. Freq. range: 100 to 10,000 mc. Type of reception CW, MCW, pulse. Signal input: 500 uv to 1 v $149.50

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3C22 new $2.95 — 902A 2" scope tube new $2.95
717A Wonder tube same as 6SK7 20 for $4.95

Terms: Minimum Order $5.00. 25% deposit required on all COD orders. All prices FOB Los Angeles and subject to change without notice. All items subject to prior sale. Calif. buyers add 4% tax.

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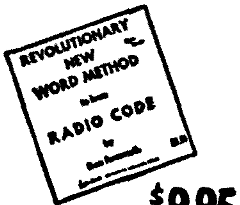

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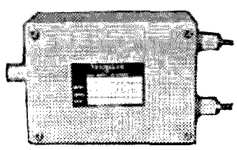

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Cosmophone SSB Xcvr 10-80, both S.B.s, 2 VFO's, ac supply, Xtal cal., $275 or towards 5 Bander mobile xcvr. cost $900. W2MUU Schultz, Sheep Lane, Locust Valley, N.Y.

COMPLETE STATION! Knight T-150 Transmitter, R-55 Receiver/calibrator, Vertical Antenna, Microphone, Key, Crystals, excellent condition. $125 plus shipping. Frank Unger, 2230 Lincoln Street, Bethlehem, Penna.

WRL's Bluebook saves money. These prices, without trades, cash or charge: HT32—$251.10; HT37—$233.10; HT40—$49.45; SX99—$85.05; HX20—$134.10; KWM1—$224.10; PMR8—$71.95; AF68—$71.95; King 500A—$206.10; HQ170C—$179.10; Ranger I—$89.95; Valiant I—$152.10; Galaxy 300—$161.10, hundreds more—free list. WRL, Box 919, Council Bluffs, Iowa 51501

COLORADO HAM DIRECTORY now available. Over 3700 current listings. $2.00. Denver Radio Club, Box 356, Denver, Colorado 80203

SONAR 10-80 METER TRANSMITTER with matching VFO: uses efficient 5894 in the final. $75 with power supply and VFO. 73 Magazine, Peterborough, N.H. 03458.

RELIABLE SSB EXCITER, the Phasemaster Jr., provides 60 watts PEP; sufficient to drive most KW linear amplifiers. $60. 73 Magazine, Peterborough, N.H. 03458.

DX-20 NOVICE TRANSMITTER. A small CW transmitter which is perfect for the beginner; all bands, 25 watts input. Only $18.00 from 73 Magazine, Peterborough, N.H. 03458.

COLLINS DELUXE PORTABLE station: KWM2-A xcvr; PM2 portable PS; Samsonite carrying case; 312B-5 Station control with PP, Wattmeter, separate VFO; 30L-1 Linear; Noise Blanker and Ant. All in excellent condition, package deal only: $1525.00 pp. Also SBE-33 and SB1-LA like new in factory cartons $375.00. WA4TAA, P.O. Box 10241, Charleston Hgts., S.C. 29411 or phone 803-747-3011.

EICO 753, solid VFO, carefully wired and factory aligned and tested, like new, $170.00 delivered in Northeast. Bob Dixon, Boulder Circle, Glastonbury, Connecticut, 06033.

ALL MAKES of new and used amateur equipment. Write or call Bob Grimes, 89 Aspen Road, Swampscott, Mass. Tel: 617-598-9700 or 617-598-2530.

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WE WILL PAY CASH: Wanted, popular, late model unmodified amateur equipment. Highest prices paid for claen, good operating gear. Write Graham Radio, Dept. 10, Reading, Massachusetts.

ARE YOU SINCERE? Are you really looking for the best deal on a new or fully guaranteed used unit? Let us convince you with a specific quote that will really save you money. Graham Radio, Dept. 10, Reading, Massachusetts.

MOTOROLA new miniature seven tube 455 kc if amplifier discriminator with circuit diagram. Complete at $2.50 each plus postage 50¢ each unit. R and R Electronics, 1953 South Yellowsprings, Springfield, Ohio.

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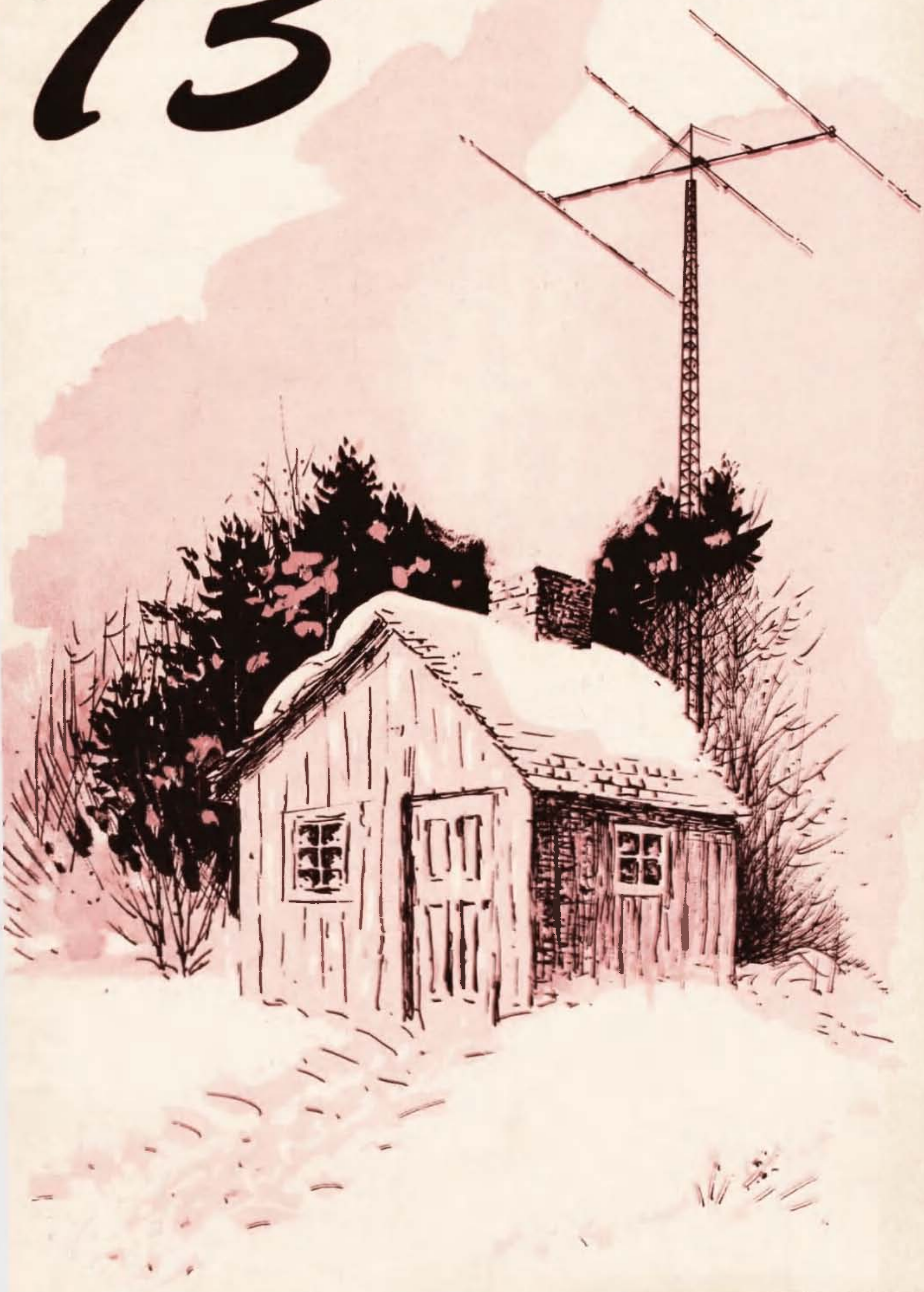
K3SUK

73 AMATEUR RADIO

DECEMBER 1966



73 Magazine

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de W2NSD/1

never say die

Fast operation

A few months back I devoted a bit of my editorial to my thoughts on techniques for working the most number of stations in the shortest time. Since then I've had several opportunities to do field work and experiment more with the various systems of fast operating.

Don's system is pretty good. He sits down on 14,104 or so and announces the band of frequencies he is tuning. This gives him the latitude to select who he wants to work, though usually the QRM is heavy enough so that even with the stations spread out over twenty or more kc only the really loud stations get through.

My arguments against this system may be small-minded, but there are a couple of things that do bother me. First of all this sort of thing ties up large segments of the band for hours on end. If it is absolutely necessary to do this to run a DXpedition, I suppose we can afford the spectrum now and then, but I don't think it really is all that necessary. Secondly, if you've tried this arrangement you know that the big guns can generally get through in a rather short time, but that some fellows spend hours and even days trying to get through. It doesn't take long before the contact has gone far beyond the limits of fun and the project has become a matter of desperation combined with growing hate and frustration.

Let's say, for example, that at one particular time there are fifty stations calling a DX station. This fifty are spread out over 20 kc of band that is in normal use at the start with fellows working DX and rag chewing. The howling mob crushes all previous activity on those frequencies in short order and the furor on the band attracts more casual tuners and soon the pack grows faster than the DXer can whittle it down. Under the usual conditions it will take our DXer about 25-30 minutes to work that fifty stations, what with repeats of call letters and waits for the more long winded chaps to finally sign their calls and stand by . . . you see, you never know when you tune in a station just how quickly he is going to shut up . . . and you find yourself listening with growing horror as he goes on and on and on calling you. By now you have so many minutes tied up in waiting for him that you hate to tune off and find someone else. Most fellows that call give your call a couple of times and then sign theirs. Often you will hear your call, tune it in and just as the other call is starting to come through someone else swishes down and starts calling you . . . and the minutes drag on.

OK, so that system has some faults, what about the others? Well, I discussed the ET3AC system of listening for a designated time off the transmitting frequency of the DX station for calls. This allows the calling stations to spread out for about two or three minutes and call so the DXer can get their call letters . . . and this is the time consuming part of the whole deal. Then he can work them break-in on his own frequency. This allows the transceive boys to play the game too.

During my trip I tried Don's system several times and, frankly, he can have it. What a miserable job that is sorting out all that QRM. And I couldn't help feeling a bit guilty about what I was doing to the band. Also, the mass of QRM made it virtually impossible to work the weaker stations until the loud ones had all been worked. And I hated to hear fellows tell me that they had been calling for over an hour.

I tried the ET3AC system a few times too. This might work fairly well if you had a band relatively free of QRM. Don's systems flattens all activity in the band he is tuning in short order and he can tune there knowing that almost any signal he hears is calling him. The mob violence to the band every ten minutes or so called for by the 3AC system doesn't chase anyone out, it just mixes everything together with the result that the DXer has one devil of a job getting very many calls written down. I did not find this much faster than Don's system.

Working transceive on your own frequency is usually pretty slow and I have kind of avoided this. I've been in too many of the pileups trying to get through to a DX station myself and know how long that fellows can keep calling in order to be the last one to call and thus be in the clear and get through. And if the DX station is weak the callers can go

(Continued on page 108)

Editors' Ramblings

Paul Franson WAICCH

Do you own your own business? Yes? Then how would you like to receive a sizeable government subsidy each month while your competition receives nothing? It would be quite a help in competing, wouldn't it? But on the other hand, how would you like to be that unsubsidized competition? No? Well, few would. This type of treatment sounds unfair to most people, yet is quite common in the U.S. It results from some laws passed long ago at a time when no one could foresee this consequence. Here's what happens:

In this country, the government has decided that certain businesses and organizations are better for the citizens of the country than others. These groups are classed "non-profit organizations," which entitles them to two major financial windfalls: they don't have to pay any taxes on their incomes like regular businesses do, and they are eligible for very low rates on much of what they mail. Of course, they have some obligations, too. They're supposed to do good—and not try to influence legislation to any great extent, i.e., lobby. But many of these non-profit organizations seem to have forgotten their main functions. The people who manage these groups, just like the managers of any other businesses, want to increase their prestige, compensation and influence, so they usually try to build empires.

The National Geographic Society is such a favored non-profit group. It is a huge organization with 1800 employees, an income last year of $48 million, and a publication with 4.8 million subscribers. The original charter of the NGS established its objectives: to increase and diffuse geographic knowledge. But its major publication, the National Geographic Magazine, can hardly be considered simply a magazine of geography. Among the recent articles in the NGM have been ones on Winston Churchill, the FBI, former U.S. Presidents, the Air Force and the Navy. It even had the exclusive rights to photo coverage of the marriage of the President's daughter last August. The NGS also publishes many colorful books and what many people consider to be the best general-use maps in the world. But many other organizations publish travel and picture magazines, attractive books and excellent maps. Many people wonder why these organizations should have to pay taxes and higher postage than the NGS when their activities are so similar.

Another non-profit organization is the National Chamber of Commerce. Its magazine, Nation's Business, has about ¾ million subscribers. The Chamber, though classed non-profit (and hence by law, non-lobbying), certainly seems to have done its share of attempting to influence legislation. It is able to do this in the same way many other non-profit groups do, by setting up separate "non-affiliated" committees and organizations to lobby, as well as by depending on individual members and their influence. Its efforts on behalf of its concepts of "free enterprise" are well known to most Americans. It condemns government interference and influence in businesses.

These two organizations pay no income taxes. Yet together with 700 similar non-profit groups, they took in $110 million in ad revenues last year. They obviously have a tremendous advantage over their tax-paying competition. The NGM competes not only with Holiday and Venture, but with Life, Look and dozens of map and globe makers. Nation's Business competes with many magazines, too. One of them is Business Week, published by McGraw-Hill. BW is far superior to NB in every respect (unless you place a high value on obvious propagandizing). But both magazines have about the same ad rates in spite of the fact that NB has about half again as many subscribers as BW. At least one of the reasons for this is obvious: Nation's Business's government subsidy. It's especially galling to see the journal of the U.S. Chamber of Commerce, the guardian of "free enterprise," competing unfairly with a tax-paying magazine by taking a government subsidy.

Another bastion of "free enterprise" is the American Medical Association, a non-profit organization. It publishes not one, but 14-ad-carrying magazines. The AMA fights subsidized medicine, but subsidized publishing is obviously another matter to them. The AMA Journal, its largest publication, carried 5700 pages of advertising ($10 million worth) last year, more than any other professional journal. Yet it pays no taxes and gets very low postal rates.

The Internal Revenue Service has been looking into the finances of these and similar organizations. They feel that at least part of the income from advertising should be liable to taxes. So far, nothing definite has come of it.

(Continued on page 110)

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Palo Alto, California

Some Thoughts on Transistor Power Supplies

Need a low-voltage power supply for transistorized equipment? This article gives you the practical information you need to keep from over- or under-building.

The power-supply is usually the very last part of the circuit to be built into an electronic design. This is perhaps as it should be, since the circuit designer often doesn't *really* know the exact voltage and current requirements until the design is done. But, because the power-supply *is* last, it often is a victim of the "dollar-short and day-late" effect. Also, the power-supply may suffer at the hands of a designer too well-steeped in the ac-dc broadcast receiver practice, to the point where "power-supply" and "a rectifier and a capacitor" are synonymous.

The author's point of view is that the power-supply should not be an after-thought, but rather should be well designed; since a good power-supply can effect many simplifications in the associated circuit design. Also, in this age of very inexpensive diodes and transistors, the difference between a rough power-supply and quite a nice power-supply is only a matter of a couple dollars worth of parts.

If one accepts the idea that a good power-supply design is desirable, will result in a better overall circuit, and will save design time to boot; how does he approach the total design? Or, which comes first, the chicken or the egg? If one first builds himself a laboratory power supply which has *all* the features of any supply he could want, he can use it to try out each circuit, as it is designed. Then, having a circuit that works well with the lab power-supply, one can design a simpler power-supply that encorporates only the *needed* aspects of the laboratory unit.

See the article, "A Laboratory-Type Power Supply," in this issue for a very useful lab supply.

Transformers can be inexpensive

The design of a power-supply almost invariably requires the use of a transformer. This is for two reasons: isolation from the powerline and obtaining a voltage different from the line voltage. The transformer is likely to be the highest priced single item in the power-supply, so resourcefulness in choosing a power transformer can really save money. Utilization of transformers that are available everywhere avoids buying the special types with their high price tags.

It is almost a truism that any electronic part we can use that is made for an automobile or a TV set is at the rock-bottom price for an item of its type. This is simply because the TV set and the auto represent "essentials" to the American public—everyone has at least one. Further, junk TV's and autos abound, and the price of a part is even lower after its carrier's demise. The large number of amateur transmitters powered by old TV set transformers is witness to this fact. One can find 6.3 Vac transformers in some of the junk TV sets; they were used to provide heater voltage to some or all of the tubes, while plate voltage was obtained using a semiconductor doubled directly from the power line. These 6.3 volt heater transformers can be useful in transistor power supplies used in the full wave bridge or conventional doubler circuits.

The early 12 V auto radios (with tubes that utilized +100 to +150 volts for plate voltage) are another source of a power transformer. If we simply connect the 117 Vac line across half the HV secondary (center-tap to one side), we will get about 12 Vac each side of the primary center-tap.

A surplus 24 V vibrator transformer represents an even more useful find. If the HV secondary is about 100 V each side of center-tap, such a transformer will put out about 24 V each side of the primary centertap. This higher voltage is more desirable in most instances.

Oh yes, don't forget to dig the silicon or germanium rectifiers out of the old TV set; they work just as well for low voltage transistor power supplies as they did supplying several hundred millamperes of B+ to the TV tubes. Although large by modern standards, Sarkes-Tarzian M500's and the like have worked very well in the low-voltage power supplies built by this author.

Rectifier circuits

In the area of 60-Hz single-phase rectifiers, there are five types of circuits that we'll be concerned with. These are "half-wave," "full-

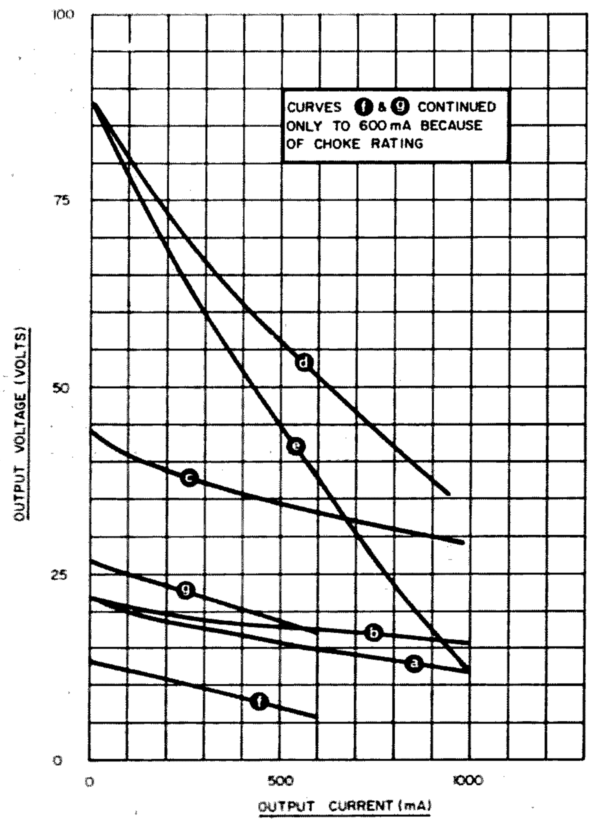

Fig. 2. Performance of the rectifier circuits in Fig. 1.

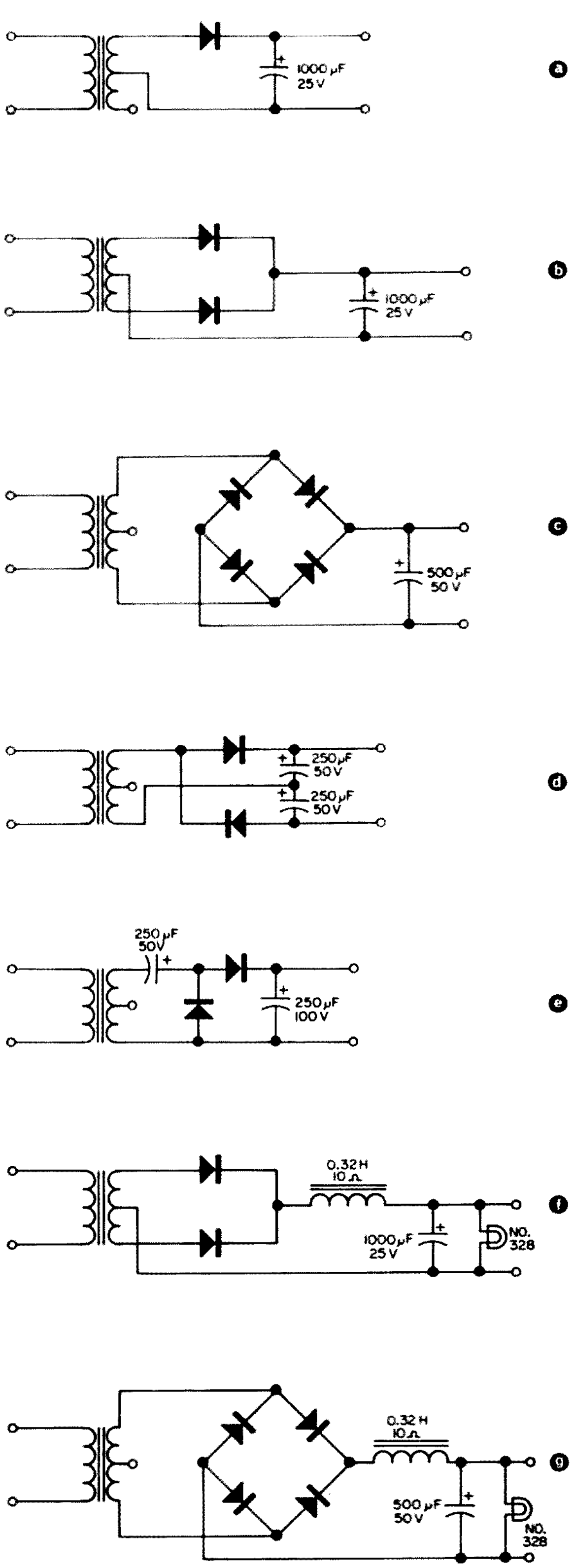

Fig. 1. The six basic types of rectifiers. a is a simple half-wave rectifier; b, full wave; c, bridge; d, conventional (full-wave) doubler; e, cascade (half-wave) doubler. The preceding are all capacitor input circuits. f is a full-wave rectifier with choke input and g a bridge rectifier with choke input. Performance of these rectifier circuits can be seen from curves in Fig. 2.

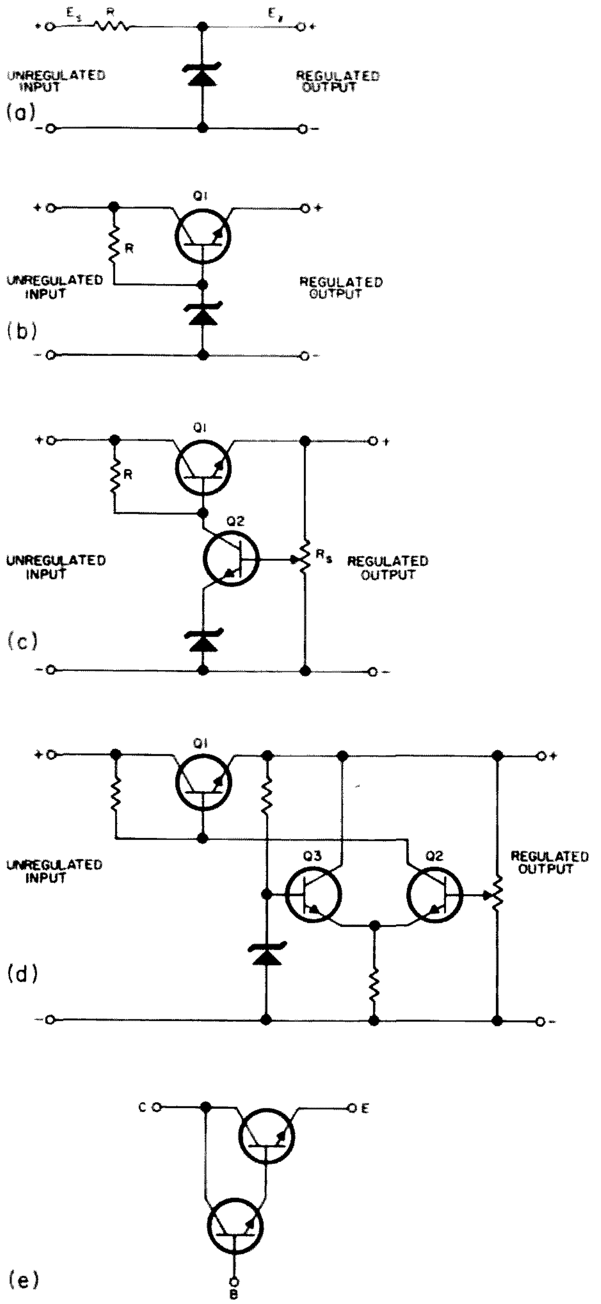

Fig. 3. Regulator circuits. a shows a zener regulator; **b,** an emitter follower regulator; **c,** an emitter follower with amplifier; **d,** emitter follower with full differential amplifier. The circuit in e is a Darlington Pair of transistors which acts as a single transistor with higher gain.

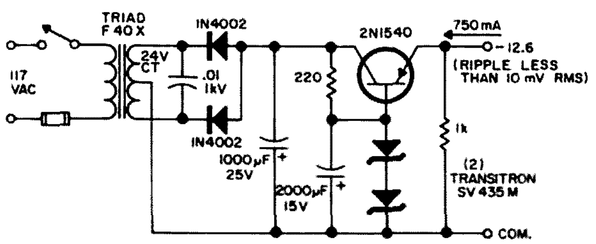

Fig. 4. Simple emitter follower regulated power supply for the heaters of five 12AX7's.

wave," "bridge," "conventional doubler," and "cascade doubler." These are illustrated in **Fig. 1.**

The "full-wave," "bridge," and "conventional doubler" circuits all charge their filter capacitors continuously throughout the 60-Hz period. This continuous type of rectifier output waveform contains no 60-Hz components, but only 120-Hz which is more easily filtered. The "half-wave" and "cascade doubler" circuits, having considerable 60-Hz energy, in their output waveforms, will prove to be the most difficult to filter and will have poorer regulation than the others. However, these relatively less desirable circuits are the only circuits one can use, if one side of the transformer secondary *must* be grounded for some reason.

With all these rectifier circuits at our disposal, *and* with the additional variation of being able to choose either "capacitor input" or "choke input" to our filter section, in full wave or bridge circuits, a given transformer can provide us a variety of dc output voltages.

To illustrate the variations of performance available with one transformer, a Triad F40X 24-volt center-tapped transformer was used in all the seven variations of **Fig. 1.** Then each circuit's voltage-current characteristic was tested; these are shown in **Fig. 2.** To make the circuits comparable, the "capacitor-bulk" (µF x voltage) was kept constant throughout. That is, the constant bulk concept would equate 500 µF at 50 V with 1000 µF at 25 V. Note that in **Figs. 2f** and **2g** (the choke input cases) that a pilot lamp was added as a "bleeder resistor." This is in line with the advice given by Terman, where he states that a minimum load must be furnished a choke input system of 1130L.[2] That is, for full-wave rectifiers operating from 60-Hz, R should be less than or equal to 1130L (where L is in henries). For our example, L was 0.32 henries so R should be 362 ohms or less. The number 327 bulb is approximately such a resistance at the voltages used, and provides a "free" pilot lamp for the supply.

Regulators

Having developed a number of rectifier-filter circuits, it is clear that they *all* have some lack of regulation. If we wish to provide our associated electronic circuit with a very constant voltage, some form of voltage regulation must be added. There are a number of methods of regulation, but the one this author has had the most experience with, is series regulation.

The series regulator can be easily developed,

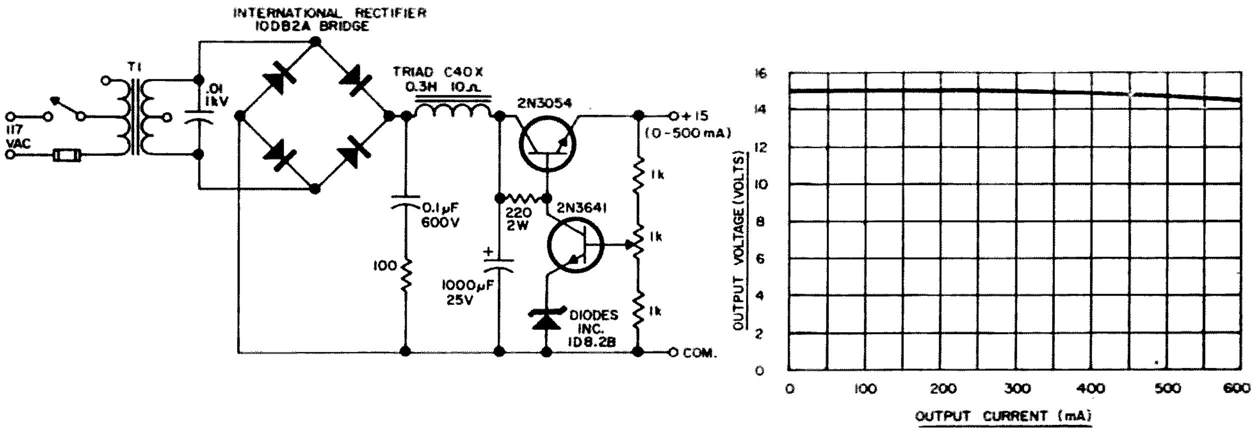

Fig. 5. Circuit and performance of a regulated power supply using the basic circuit of Fig. 3c. T1 is a surplus vibrator transformer marked 25.2 Vdc input and 135 Vdc, 118 mA output, vibrator frequency 115 Hz. Half of the high voltage winding is used in this circuit.

for understanding, as follows. Consider first of all a simple zener-regulator, as in **Fig 3a.** The output voltage characteristic is that of the zener diode, providing that the load current doesn't exceed (Es − Ez)/R. A capacitor can be added in shunt with the zener diode, to afford additional ripple filtering. Note that the addition of this capacitor *will* work in a zener diode circuit whereas it will often *not* work in a VR tube circuit, since the zener diode has no region of negative resistance. One serious drawback of the zener regulator is that the zener voltage *does* change somewhat with zener current. See the article on zener diodes by W2DXH in the October 73 for more information on zeners.

A better regulator is the "emitter-follower" type, wherein a transistor is used as a series resistance, as in **Fig. 3b.** The base of the transistor is held at a constant voltage by a zener diode which derives its current through R from the unregulated input. Since the current flowing into the base is I_c/h_{FE}, the zener current can be much less than in the simple zener regulator. If we make R small so that the zener current is large compared to the maximum base current the transistor will ever draw, the percent variation in zener voltage can be made fairly small. Again, a capacitor can be put in shunt with the zener, giving the ripple reduction of the well-known "capacitive multiplier."

Perhaps the next step, in sophistication, is to add dc gain to our series-regulator as in **Fig. 3c.** In this circuit one is not tied down to the zener voltage to determine the output voltage. In fact, the output voltage is adjustable, over a few percent, with the output sample-pot, Rs. The circuit still suffers somewhat from variations in zener current with load current, however.

Finally, then, we add the full differential amplifier for our gain stage as in **Fig. 3d.** Now, since the zener diode derives its current from the output side of the regulator, the zener current is nearly constant and so is the zener voltage. As in **Fig. 3c,** the output is adjustable over a few percent.

In all the circuits **3b, 3c,** and **3d,** it is possible to replace the series transistor (Q_1) with a "Darlington Pair"; That is, replace one transistor with two as in **Fig. 3e.** This com-

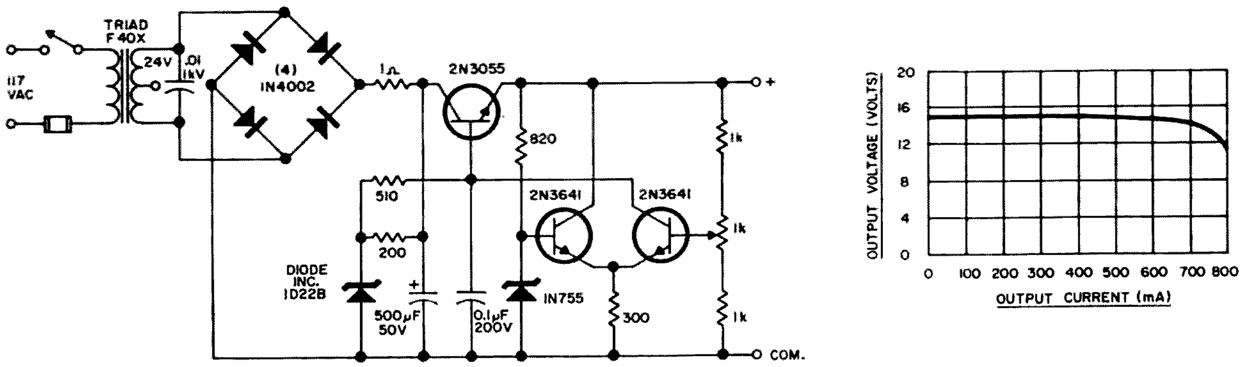

Fig. 6. Practical supply using a differential pair amplifier.

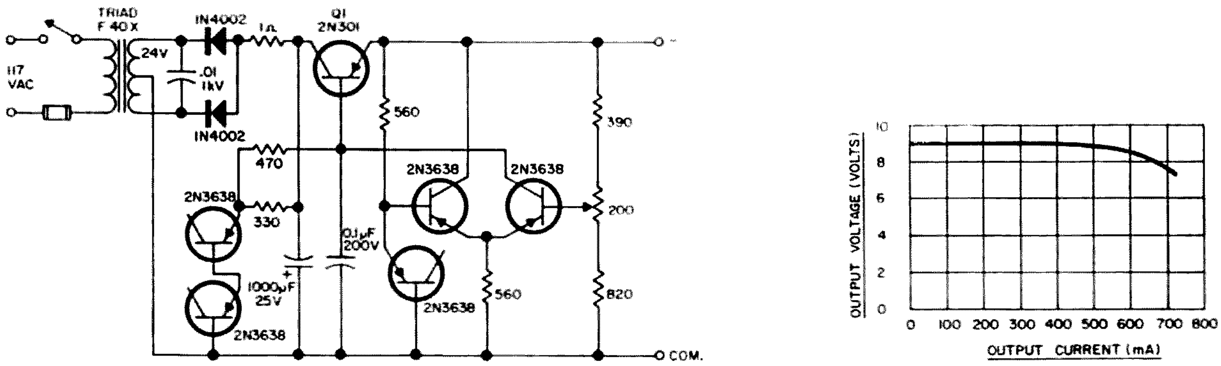

Fig. 7. Another differential pair regulated supply. Here the base-emitter junctions of inexpensive transistors are used as zener diodes.

bination yields the equivalent of a transistor with the product of the h_{FE}'s of the two component transistors. This will allow us to use higher dc gain in the regulator system, affording better performance. The Darlington pair method is a way of obtaining a high-h_{FE} power-transistor for use as Q_1.

Examples of practical circuits

Having looked at a variety of series-regulators, a selection of real-life examples to illustrate them may be in order. These are presented in **Figs. 4, 5,** and **6.** The circuits are not so-designed to make value judgments between types, but are simply examples from the author's back file.

Another differential regulated supply is presented in **Fig. 7** to illustrate a trick in substituting the base-emitter junctions of inexpensive silicon transistors, for zener diodes. Note that in both **Figs. 6** and **7** a "pre-regulator" zener diode is used to supply half the differential amplifier with collector voltage. This "pre-regulator" and series regulator system is quite extensively covered in the Texas Instruments book *Transistor Circuit Design.*[3]

One will also notice that in the examples of **Figs. 4, 5, 6** and **7** that there is added, across the transformer secondary, a 0.01 μF 1 kV disc ceramic capacitor. This is a line transient suppressor which is to "kill" any line spikes that may otherwise exceed the PIV of our rectifiers. Another type of transient suppressor is useful in choke-input filter systems; a 100-Ω resistor and 0.1 μF capacitor, (in series) are put ahead of the choke, as if to provide capacitor input. This serves to dampen the voltage created by the choke field-collapse when the supply is turned off. This technique is used in **Fig. 5.**

Fig. 8 is a regulated power-supply for use with the inexpensive epoxy-encapulated Fairchild integrated circuits. These epoxy IC's are specified for +3.5 to −4.5 volts. This regulator utilizes one of the old 2.5 V filament transformers that was put in the junk-box when you replaced the 816's or 866A's with silicon HV rectifiers. The Fairchild μL923 (a J-K Flip Flop) takes about 20 mA, so this power supply will run up to 15 of them.

This design, a low-voltage one, brings out several of the worst points in series-regulator design. Since the difference between rectifier voltage (point A) and the regulator output voltage (point C) is only a few volts at most, the (small) voltage drop of the base-emitter junction becomes appreciable percentage-wise.

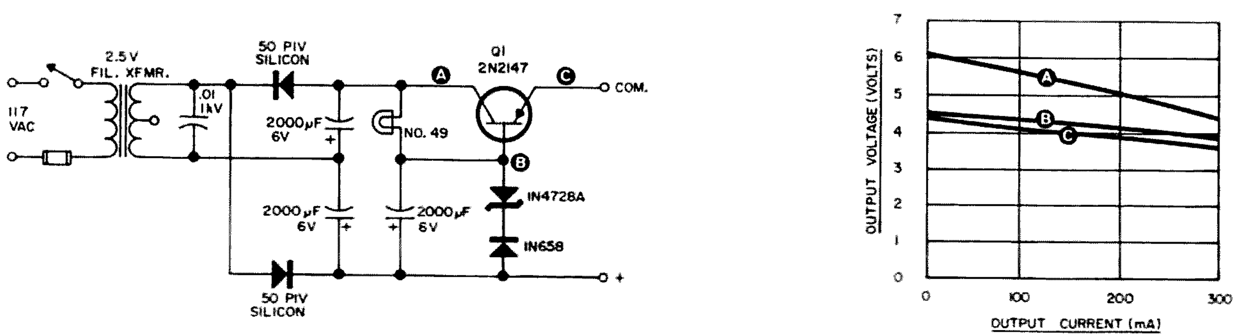

Fig. 8. Regulated power supply designed for use with inexpensive Fairchild integrated circuits. The letters on the graph refer to the voltages at the points shown on the schematic.

Since germanium transistors have lower emitter-base drop, a germanium unit is used here; a high h_{FE} germanium type was chosen, the 2N2147.

Fig. 8 is similar to the regulator of Fig. 3b, except that R has been replaced by a #49 (2 V, 60 mA) pilot lamp. This trick was necessary to help hold the zener current more nearly constant. The bulb acts as a nonlinear resistor, increasing its resistance as the voltage across it increases. The 1N658 diode in series with the 1N4728A was simply used to "jack-up" the reference voltage about 0.7 V, over what the zener alone turned out to be. In this circuit, this forward-biased diode *does not* effect a temperature compensation.

Also, low-voltage brings out the worst in zener diodes. This is illustrated in **Fig. 9.** Notice that for zener diodes with voltages below about 6 volts, the "knees" do not have a sharp "break," but are quite rounded. This phenomomenon is associated with the different mechanism of breakdown at the lower voltages. (To be really correct, one should only call regulator diodes that break down below about 6 volts "zeners" since this is in the zener region. Similarly regulator diodes that break down above 6 volts should be called "avalanche" diodes. However, the technology has come to call them *all* zeners.) The "soft-knee," as this rounding-over at breakdown is called, can be coped with by running more zener diode current, within the dissipation limits of the diode.

This "soft-knee" behavior of low-voltage zeners is not all as bad as it might be. It turns out that the "zener" and "avalanche" regions of breakdown have opposite temperature characteristics. So that at about 5 volts (see **Fig. 9b**) the two opposite temperature coefficients cancel, yielding a ready-made temperature-compensated reference diode.

At breakdown voltages above 5 or 6 volts, we are operating with a positive temperature coefficient, in the avalanche region. Since the temperature coefficient of an ordinary silicon diode or rectifier, when forward-biased, is negative; the arrangement of **Fig. 10** can be used to help temperature-compensate higher voltage breakdown diodes.

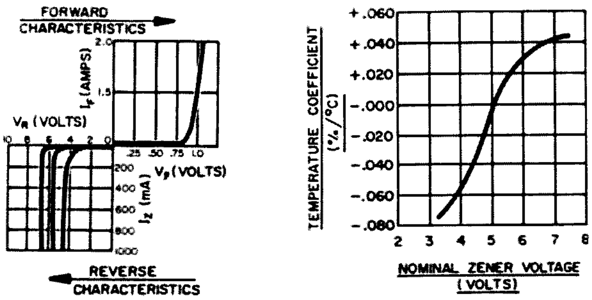

Fig. 9. a, on the left, gives the reverse characteristics of low-voltage zener diodes. b, on the right, shows how the temperature coefficient of zeners is lowest at about 5 volts.

There is certainly a lot more that could be said on power-supplies and regulators, and the author knows he has only touched on a vast subject. For more detailed coverage of the subject, the first three reference have much more material. Also, Kepco Electronics has put out a very useful little paper-bound book on regulators.[4] Another useful reference is the easy-to-use (complete with graphs) article in Electronic Products, on rectifiers and filters.[5]

I'd like to thank Don Powers, WA6NJD, for his helpful discussion in preparing this manuscript.

. . . W6GXN

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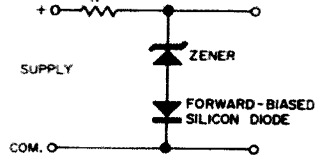

Fig. 10. Temperature compensation of a zener diode (for use with zener diodes of greater than 5 or 6 volts).

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Burlingame, Calif.

The Sideband Escalator

Have you tried SSB speech clipping lately?

The first known successful amateur application of speech clipping in single sideband service was made by Squires and Clegg who incorporated it in the Clegg SS Booster as an aid to their Venus six meter transceiver with interesting results.[1] The effect of adding the booster unit was found to be comparable to adding a linear amplifier to the SSB exciter by raising the average power output of the signal relative to its peak power.

Although audio clipping had, in the past, been employed in AM transmitters with varying degrees of success in attempting to add talk-power to the radiated signal, its use in single side band service is not feasible because the output envelope pattern (as viewed on an oscilloscope) is not a replica of the original audio wave form, as Squires and Clegg clearly emphasize.

Since average radiated power can be increased with rf speech clipping almost up to the peak power level, the plate efficiency of the final tubes is thereby increased with consequent reduction in plate dissipation. Hence, the tubes run cooler. The plate supply must be capable of furnishing the additional current demands made on it.

Briefly, this is how the system works. The rf signal in the SSB exciter unit (employing a high amount of audio gain) is extracted at the output of the balanced modulator or *if* stage following it and coax-fed into the outboard speech clipper unit where it enters a narrow bandpass filter similar to the one in the exciter unit. After the rf signal has been properly wave-shaped into a SSB signal by the filter, it is then fed into a remote cut-off pentode with adjustable gain in order to recover the insertion loss of the filter and to provide the necessary clipping gain. The output of the pentode is transformer coupled to a pair of positively biased crystal diodes which amplitude-clip the resulting wave form. A second remote cut-off pentode with variable output gain provides transformer coupling of the output signal from the speech clipper unit by way of coax cable back into the input of the original bandpass filter of the SSB exciter. The second *if* transformer, and principally the filter in the exciter, remove the objectionable frequencies generated by the clipping action of the diodes.

The circuit diagram of the rf speech clipper is shown in **Fig. 1.** Provision is made (1) for internal switching of the signal within the SSB exciter for inboard or outboard service (2) for switching the clipper itself in or out with separate gain controls, whether in or out (3) for varying the threshold bias on the 1N34A diodes with the peak limiting control and (4) for varying the output gain to prevent overloading of the succeeding stages in the SSB exciter.

Construction

The layout of the principal components appears in **Fig. 2.** The power supply and the speech clipper are each constructed on a 2"x4"x6" aluminum chassis. This permits the power supply to be placed out of the way. The speech clipper is placed next to the exciter unit.

The 455 kHz mechanical filter, **F1**, is mounted underneath on a small rectangular aluminum plate large enough to accept two transistor sockets for inserting the filter. The plate, itself, rests on two metal stand-offs. The filter's input and output circuits are shielded from each other by means of a small baffle plate at the midway point. The filter employed should be similar to the one used in the exciter.

A sub-miniature ceramic switch, S1, is

[1]QST, July 1964, p. 11; QST, August 1964, p. 117. "Acknowledgement must also be given to Don Stichler, KL7EBK, whose successful use of the Squires-Clegg type of clipper prompted the writer to duplicate his efforts, although each of us employed different modifications of the original circuit."

placed as close as possible to the output of the exciter's balanced modulator or first *if* amplifier. In this instance, in which the exciter was a Collins 32S-1, the lead was cut between the coupling capacitor, C140 and R106(22kΩ) at the entrance of the mechanical filter, FL 1. The small hole for the switch was drilled in the left bottom corner of the black border line inscription carrying the serial number. Small size RG 174/U coax cable connected the switch contacts to the two jacks at the rear of the exciter, the spare jack and the converter output jack, J18. (The lead from J18 was disconnected, since two meter operation is not contemplated). In different exciters, provision will have to be made for the addition of two rf phono jacks if spare jacks are not available. Two one-foot lengths of RG 58A/U coax cable with rf phono plugs at each end were used to connect the clipper unit's input and output with those of the exciter unit.

Adjustment

1. The speech clipper is first tested separately on the bench as follows. With the switch, S2, in noclip position, apply an rf signal of the appropriate frequency from an rf signal generator to the grid of the 6DC6 tube and peak the signal with the trimmers on T1 and T2 with the aid of a vacuum tube voltmeter and rf probe or oscilloscope connected at the output jack, J2. Check to see if the output control, R4, is working properly. Adjust the coupling screw on T1 for critical coupling (a single peak of maximum intensity —not a double-humped peak). It will be necessary to swing the rf generator frequency a little to observe the coupling action.

2. With the rf generator signal somewhat attenuated (so as not to damage the filter) apply the signal at the input of the filter at J1 and note the output reading. It may be necessary to swing the generator frequency slightly in order to peak the signal. Compare the signal output when the rf signal is applied at the input of V1 and at the input of the filter, and note the considerable improvement in sharpness of response and insertion loss of the filter. Finally, re-peak the *if* trimmers to obtain maximum output.

3. Test to see if the gain controls in the clipper and no-clipper modes are working by observing the rf output voltage. Check the

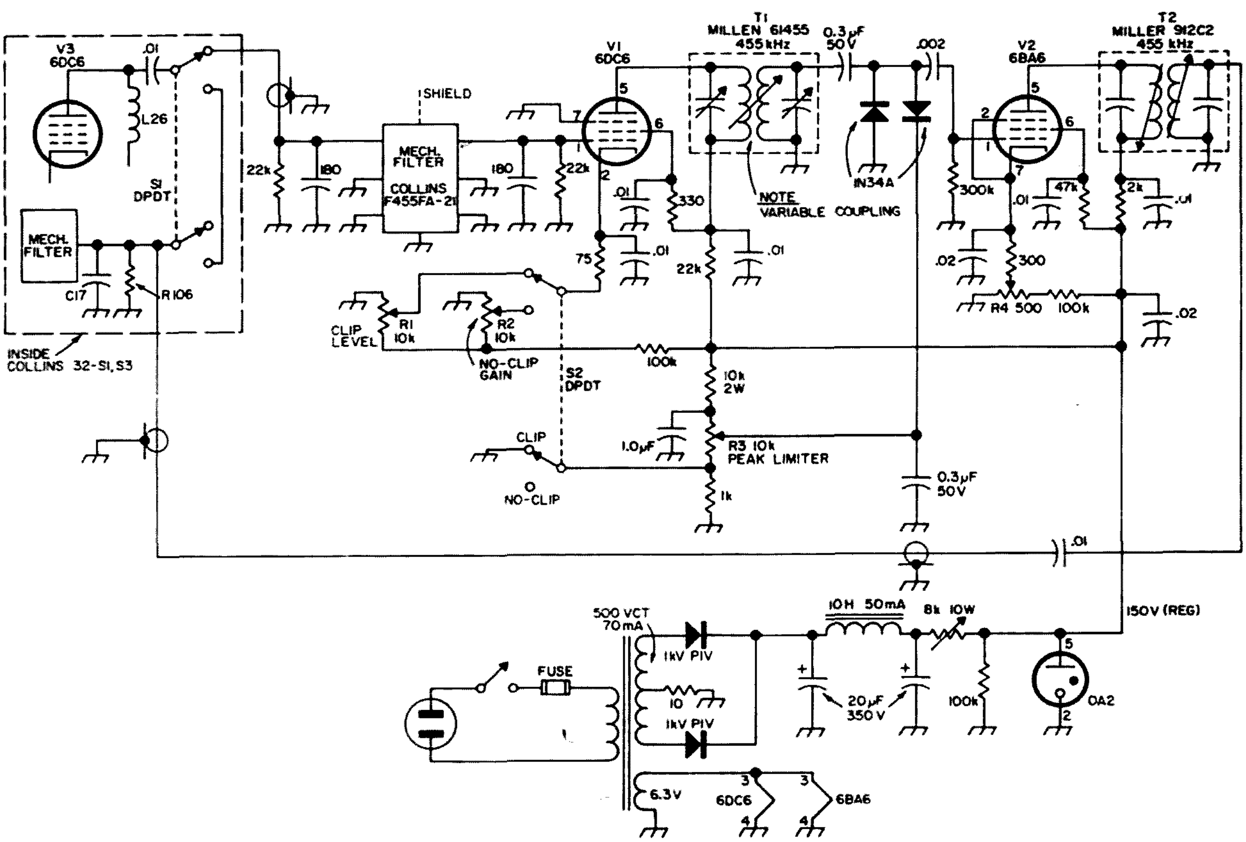


Fig. 1. Schematic of the single sideband escalator. This is a speech clipper-processor for improving the results of SSB transmission. It raises the ratio of average to peak power transmitted.

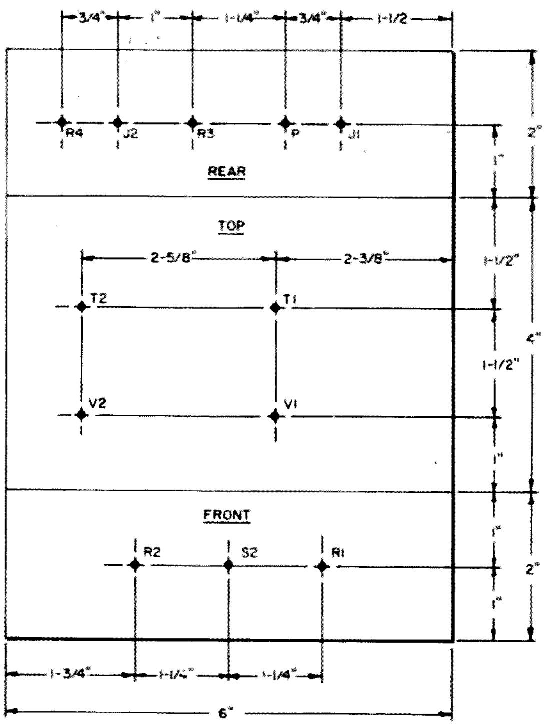


Fig. 2. One-third size layout of the escalator.

action of the peak limiter control by measuring the voltage change at the diodes. An oscilloscope with a sufficiently high horizontal frequency sweep should reveal the clipping action of the amplified sine wave signal from the rf generator when R3 is rotated from minimum to maximum position with the switch, S2, in the clipping mode.

4. Attach a dummy load and Heathkit monitor scope (or whatever) to the output of the exciter unit. First check the ceramic switch, S1, to see if the exciter tunes normally without the clipper in the circuit. Next switch S1 to the clipper. Place switch, S2, in noclip mode, advance the audio gain of the exciter as far as possible without overloading the preceding stages. With the exciter loaded in the key down position, advance the noclip gain control slightly while observing the SSB pattern in the oscilloscope. Adjust the *if* trimmers for maximum carrier output. Also adjust the output gain control, R4, so as not to overload the succeeding stages in the exciter. With a nominal amount of noclip gain and proper attenuation of the output signal from the clipper, one should get a satisfactory voice envelope pattern without flat-topping just as with the exciter alone. Audio control is exercised by R2 and not by the exciter's audio gain control.

5. Switch S2 to the clipping mode; set clipper gain at maximum. Adjust peak limiter control, R3, so that the voice peaks are at the same output level as in the noclip mode as observed in the monitor scope. The clipping level gain control establishes the degree of clipping. Notes the definite increase in average plate current of the exciter and more nearly filled in wave envelope scope pattern between no clipping and various settings of the clipping control. This difference is plainly audible in your receiver. With the system working properly, the increase in average output power should so register on most receiver S meters and definitely in talk power.

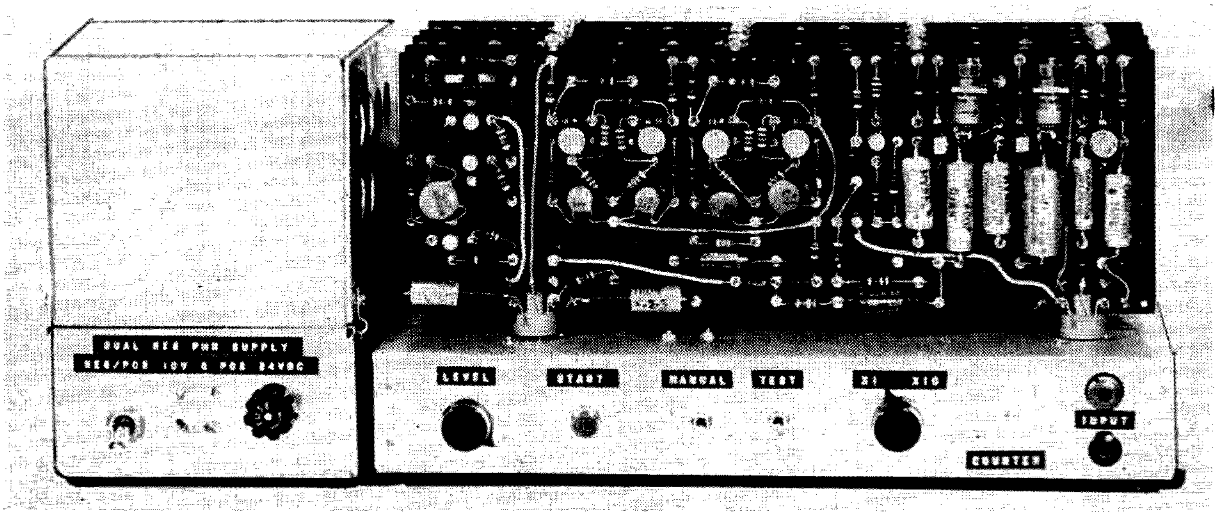
Summary

On the air tests have amply demonstrated the superiority of the rf speech clipper over a three-tube audio compressor pre-amplifier which could be switched in and out for comparison purposes. The operator at the other end invariably reported that the rf clipper supplied more "muscle" than the audio compressor. If the audio gain is increased under audio compression, in an attempt to raise the average-to-peak power ratio, the final plate current meter will show this increase at the expense of flattening the wave form with consequent distortion and undesirable new frequencies.

On the other hand, with rf speech clipping, the peak limiting control sets the maximum output power available without flat-topping for any amount of clipping up to about 30 dB, no matter how loud one talks or shouts. Even under maximum clipping, there is still sufficient intelligibility though with definite distortion. It was found from on-the-air checks that about 15-20 dB of clipping was usually the best; at this setting, the voice characteristics remained relatively unchanged compared to noclip operation. Even in the no clipping, or normal position, there is the added advantage in having a second narrow bandpass filter active in the system. Who would object to that?

Some final words: your power supply must be capable of making the additional sacrifice necessitated by speech clipping. Make certain that the carrier is nulled out and that hum and extraneous noise are minimized. There may be a fly in the ointment for the kW operators. The FCC regulation relative to DC power input may be violated due to increased average power input unless proper precautions are taken, even though the peak envelope power remains at 2 kW. To those who aspire to the kW class, but whose equipment does not quite have the "muscle," take heart, for here is the opportunity to upgrade yourself at relatively little cost.

. . . W6TAQ



General view of the counter with attached power supply. The control panel is shown here. Some components have been eliminated and certain design changes have been made since this photo was taken.

An Electronic Counter for Amateur Use

This counter gives a very accurate frequency count for low frequencies. It's neither expensive nor hard to build.

Numerous magazine articles appearing from time to time, call for a digital counter to perform exact (or nearly so) frequency measurements. One specific instance was in the January 1966 issue of 73.*

This instrument, like my Lampkin Frequency Meter is indispensable when needed. Whereas the LFM is used for high frequencies, this counter covers the lower ones, from one hertz to 250 kHz. Though the digital counter can not be employed as a signal source, its capability for determining a frequency is remarkable.

It is entirely automatic in operation. The signal to be counted is connected to the input terminals of the counter. The start button is pressed and one second later the "coded" frequency is read from the lighted lamps. The "code" will be explained later.

*A Signal Generator for the RTTY Man Page 36, Adjustment

Philip is a retired warrant officer (USN) and retired member of the civil service. He has written a number of articles for various magazines, and is interested in ragchewing and code.

Uses of counter

Sometime ago trouble was experienced with my audio generator. It had been unstable from the beginning. Without going into details, stability was secured at the expense of a reduction in frequency coverage, which of course meant recalibrating the scales. With the aid of the counter this was accomplished in a very short time, and with great accuracy.

If you find that your 10 kHz multivibrator doesn't synchronize at a 10-1 ratio with your 100 kHz oscillator, readjustment is quite easy. Feed its output into the counter and check its frequency. Change the value of the cross-coupling resistor until the correct frequency reading is obtained.

The two oscillators in a two-tone generator can be set very accurately in a similar fashion.

If you wish to check the lower dial graduations on your rf signal generator, you can do so if it's output is amplified. A simple solution was found by using a one-stage preamp feed-

ing a 9 V 360 mW audio amplifier. A volume control, hooked up as recommended with these units will minimize distortion if it should present a problem, though the pulse shaper of the counter will accept almost any type of pulsed signal.

It is possible to pick up a signal off the plate lead of the *if* tube in low level stages of your receiver. A capacitor of the proper voltage rating may be used in series with the counter input. The signal generator is connected to the grid of the preceding mixer tube in the usual manner. As a rule these low stages are aligned by an unmodulated output from the signal generator.

Theory of operation

The simplified electronic counter will do all of the above things and more. It is stripped of all non-essentials, though completely automatic in operation, and can be built inexpensively by utilizing surplus sources for most of the materials. Commercial counters run in the $300 up, class. This unit will cost about one-quarter as much.

Fig. 1 is a block diagram of the decade counters and the control circuitry. Four indicating decades give visual readout to 10 kHz. Above this frequency the x10 decade is switched in to multiply all indicating numbers by ten. In either case, the number of cycles made by the counter is determined by noting how many times the last lamp in the series flashes; extending the count beyond that actually indicated.

Counting can be done to one hertz, but this is seldom realized in practice due to unstability of signal sources, voltage and frequency excursions and the simplified design of the timing and control circuits. With a 10kHz crystal controlled signal source this unit will give repetitive accuracy of 3 hertz, and at 100 kHz, within 50 hertz.

The start button has two functions. Pressing it resets all flip-flops and extinguishes all lamps. Operation begins by releasing this button.

The input signal is fed to the pulse shaper whose output is tied to the count gate. The signal is then passed to the counter. Counter operation is continuous as long as the count gate remains open. (or by-passed with the manual switch). This gate opens and closes in sequence to signals from the #1 control flip-flop whose state depends upon pulses from the timing generator. To limit the number of pulses to this multivibrator, a second flip-flop receiving its signal from the first and working at one-half the speed, closes the pulse gate after the second pulse from the timer. This shuts off the counter. The lamps that remain on in the decades, indicate the count.

The manual and test switches are shown in dotted form since they are not needed for normal operations. The test switch is placed in series at the point marked X. In their "off" position, the test switch contacts are closed and the manual switch contacts are open.

The bistable multivibrator or flip-flop, **Fig. 2**, is made with two transistors cross-coupled to form an oscillator having two states, on and

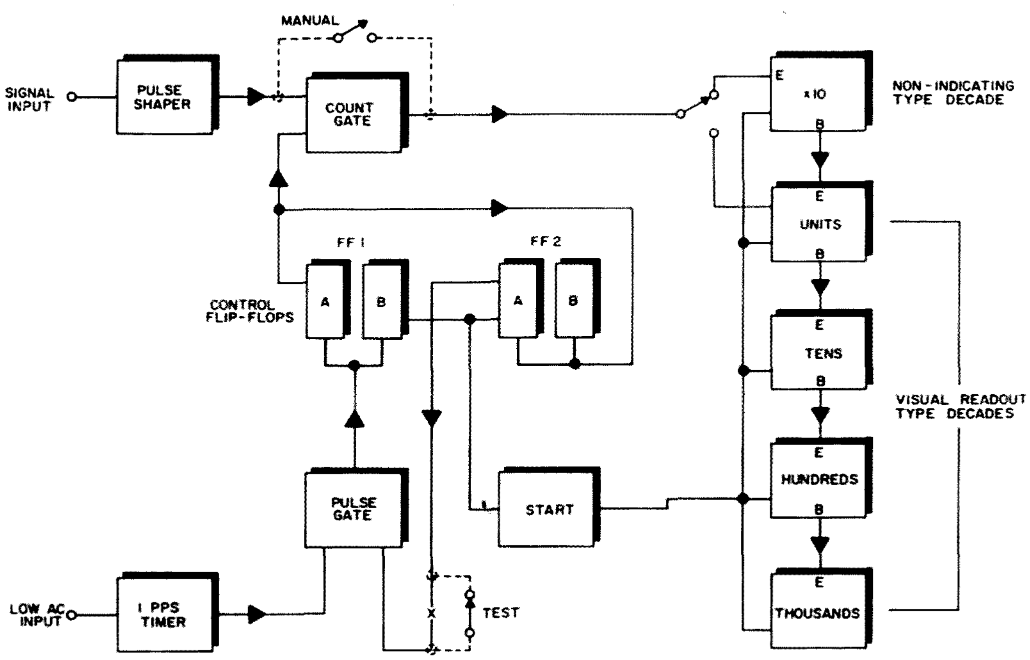


Fig. 1. Automatic counter control.

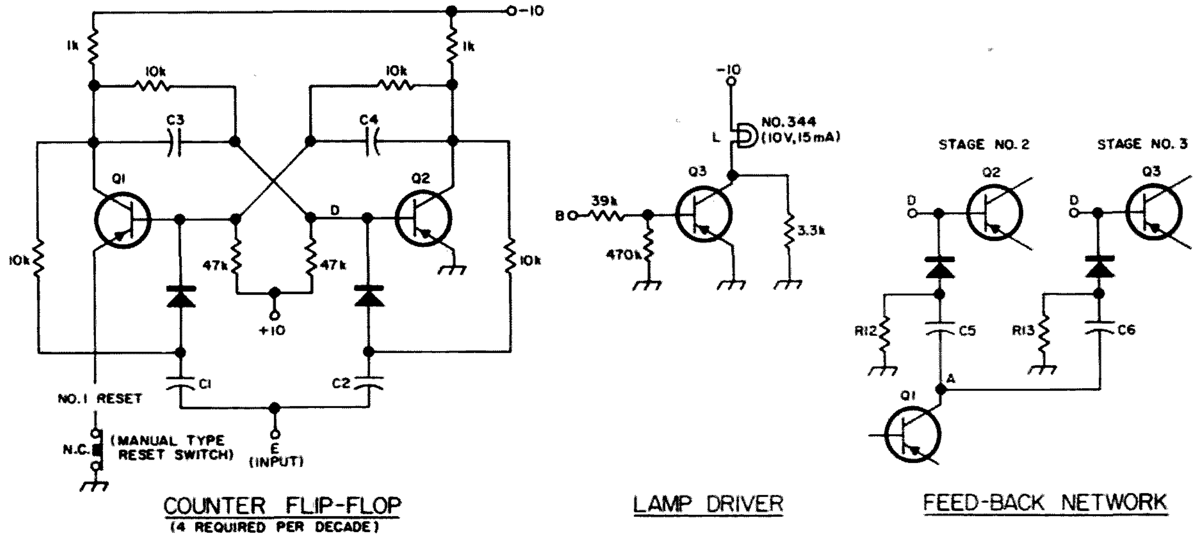


Fig. 2. Counter flip flop, lamp driver and feedback network.

off. When Q1 is on or conducting, its collector potential is almost zero. Q2 is then off with about −8 volts on its collector. (Table, Q conditions)

Q Conditions — Nominal voltage at collectors

State	Q1	Q2	Q3	Lamp
1	off −8	on 0	−9	off
2	on 0	off −8	0	on

Reset switch places all flip-flops to state 1.

To obtain visual readout a lamp driving transistor is connected to the collector of Q2 of each stage. As Q2 turns off a bias is placed on the base of Q3, causing it to conduct. The resultant voltage drop across the lamp turns it on. The 3.3-kΩ by-pass resistor allows a few milliamps to flow through the bulb at all times, keeping it warm and adding to the stability of the circuit.

The Q1 emitters of all decade flip-flops are placed on the #1 reset line to the starting relay. Opening the ground connection turns off these transistors and consequently, all lamps.

The multivibrator design provides satisfactory operation with transistors having a beta of 25 or more, though excessive leakage will cause failure. The cross-coupling and collector load resistors can be increased somewhat for tighter control, but loading requirements and component tolerances must be considered when doing this.

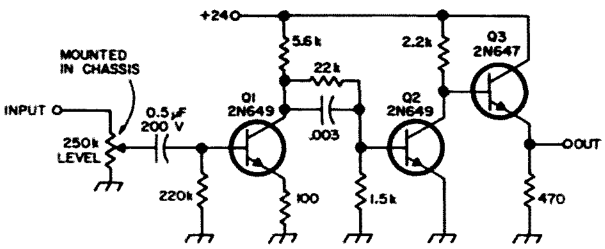


Fig. 3. Pulse shaper.

Feedback is introduced from Q1 of the fourth stage to Q2 of stages 2 and 3 to provide decade operation. This type of feedback is easy to adjust and has proven reliable. One resistor and capacitor form a differentiating network and defines the amplitude and shape of the pulse to its respective stage.

Finding the correct resistance value is not too difficult with a scope. Feed a sine wave signal of 5 kHz to 10 kHz into the counter. Set the scope controls for a ten hertz display of the input signal. Five hertz will appear on the collector of Q2, stage 1 and one hertz at Q2, stage 4. One can reverse this procedure, obtaining one hertz on the 4th stage, then if three hertz or an unsteady waveform is seen on the first stage, the resistance should be changed accordingly. The feedback pulse is observed at the junction of the resistor and capacitor.

At very low frequencies beyond the response of the scope, the feedback can be verified by visual examination of the lamp sequence.

Counting is actually performed by division of the unknown frequency. Each decade divides the frequency in a 10-1 ratio. Decades are placed in series to extend this division process.

The readout system employed here utilizes lamps. Each stage has a lamp and with nine numbers to interpret, a code system must be used in which one or more lights will represent a certain digit. Four decades can show a total of 9999. An additional input pulse will cause all lamps to go out, inferring the count

as 10,000. An orderly readout scheme is needed to prevent confusion. Lamps are arranged left to right for stage designation and the decades, front to back, for units to thousands. Since the decimal equivalent of all decades are evaluated in like manner, a glance at the lighted lamps will reveal the total.

The decade code is shown in **Table 1.** A number such as 1057 will appear as follows: fourth decade, stage 1; third decade, none; second decade, stages 1 and 3; first decade, stages 1, 2, 3.

With a little practice this becomes as natural as interpreting the numbers in the Morse code.

The frequency response of the pulse shaper **Fig. 3,** is set to accept sine wave signals of 150 mV and up, from 100 Hz to 100 kHz and produce constant amplitude pulses to the counter. Input signals to 25 V rms have been used without resorting to the level control. Above this, some resistance must be used. The low frequency response falls off fairly fast until at 20 hertz a 3 V signal is required. This is in part determined by the value of the input capacitors in the first stage of the counter. The emitter of Q3 is directly connected to the count gate and provides isolation for Q1 and Q2 against gate action.

The 1 PPS timing generator **Fig. 4** is composed of three UJT frequency dividers. The first acts as a saw-tooth generator and set to a 1-1 ratio with the 60 Hz ac input signal; taken from T2 of the power supply at points X-X through the two 1 μF capacitors. The 10-1 and 6-1 dividers operate as free running oscillators and are locked into synchronization by the pulse from the saw-tooth generator. The .022 μF capacitor determines the strength of this signal. Q4 is an emitter follower and gives isolation from the pulse gate.

The timing circuits are fairly critical, dependent on the components and UJTs used, and due to their load sensitivity, the entire assembly should be temporarily put together

Table 1
Decade Conversion Chart

Digit	Decade Code 1	2	3	4
0				
1	+			
2		+		
3	+	+		
4			+	
5	+		+	
6		+	+	
7	+	+	+	
8		+	+	+
9	+	+	+	+

Crosses indicate lamps on at end of counting period.

during preliminary tests and adjustments. At this stage, R2 should be adjustable and replaced later with a fixed resistor. The value of C7 is formed with two parallel capacitors.

A 1-1 ratio is easily attained on the scope, but when adjusting R5 for a 10-1 ratio relative to the outputs from Q1 and Q2, it may be more difficult. The same results can be accomplished with 5 and ½ hertz waveforms, though the ½ Hz trace is not easy to recognize until nearly stabilized.

The adjustment of R9 should wait until after the decades have been completed. An approximation can be made by counting the pulses on the CRT.

The output from a 100 kHz crystal oscillator is fed to the counter and R9 set to obtain a count of this frequency. As mentioned previously, there is a certain inherent instability which will show up in repetitive counts, so an average is taken from several tests.

Another method utilizes the output pulses from Q1 of the control flip-flops. A jumper is placed from its collector to the counter input. Turn on the test switch. The lamps will start flickering at a one second rate. These pulses come from the timer (and could be used). Reduce the load on FF1 with the level con-

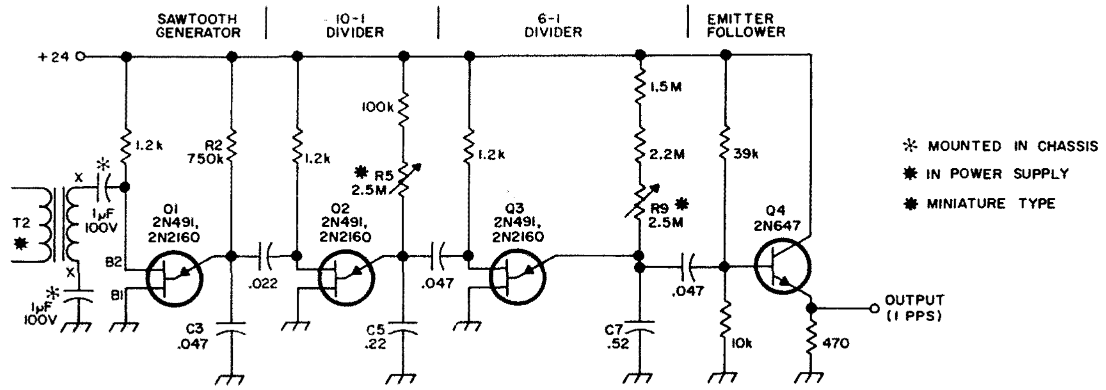
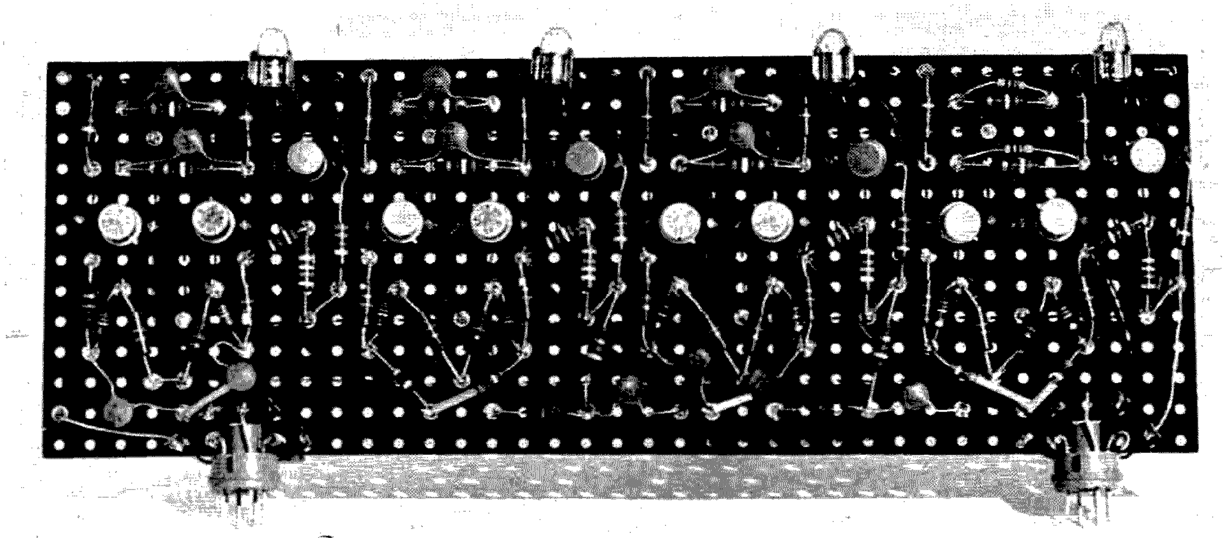


Fig. 4. One pulse per second generator.



Electronic counter decade panel contains four stages with their respective lamp and driver transistor. The feedback network is at the bottom, center, toward the right.

trol until it starts oscillating. These pulses are preferred since they are of high amplitude and produced at half the rate of the timer. Actuate the start button to begin the timing period. The count is observed at definite intervals and R9 set accordingly. The intervals are lengthened to an hour or more to achieve extreme accuracy.

The gate control circuit correlates the functions of the pulse shaper and timer. The diode gates can best be understood by referring to **Fig. 5.** Notice that D5 and D6 of the count gate have their anodes back to back and biased by the +24 volt supply to form an "AND" gate. In operation D6 has a constant +5 dc potential on its cathode. D5 though, can have either +8 or 0 volts on its cathode, depending on the condition of Q1.

When Q1 is conducting, the voltage at D5 is near ground level shunting the bias current in this direction. This lowers the gate potential to where it is insufficient to maintain a signal level high enough to actuate the counting flip-flops. In effect, the gate is closed.

Input pulses to the bases of the bistable multi-vibrators will change their state in a sequential manner. A pulse is directed through the diode of the conducting, transistor, turning it off. The opposite transistor, turning on, produces a pulse at its collector. Thus Q1 initiates the pulse necessary to trigger the second flip-flop. (**Fig. 5**)

The emitters of Q2 and Q3 are connected to the #2 reset line to the starting relay. Depressing the start button lifts the emitters off ground, turning off these transistors. Q3 therefore opens the pulse gate since its collector voltage rises to +8. Releasing the start button allows action to proceed. The first pulse from the timer is directed to Q1, opening the count gate. Processing of the unknown frequency commences. The second pulse from the timer turns Q2 off. And as explained in the preceding paragraph, Q1 actuates the second flip-flop, closing the pulse gate. The count can now be taken.

Construction

The four indicating decades and the control circuitry are mounted on 3½" x 9⅞" x 1/16" perforated boards. Two Vector P7 plugs are fitted to each panel. The long pins are bent and soldered to Vector T9.4 terminals. When done properly this makes a very strong assembly. The panels then plug into 7 pin miniature tube sockets fitted to the chassis. The lamps are mounted in standard 3AG fuse clips, which are secured to the board by hollow rivets. Soldering lugs are used in this assembly on the reverse side of the panel to connect the lamps to the −10 volt line. The center contact of the bulb presses against a Vector T9.4 terminal inserted in the hole below the clip. A flexible lead is soldered to this terminal. This mounting method is simple and has proved adequate, though not recommended for hard useage. A front panel display may be preferred and there are enough unused plug connections to accommodate this change.

The chassis measures 6" x 10¼" x 1½" and made from 1/16" aluminum. The first panel is placed 1¼" from the front and the others spaced 1" apart.

If a cover is used over the panels, two stay rods with insulated spacers are fitted on each end of the panels to align them so the lamps will clear the holes in the cover.

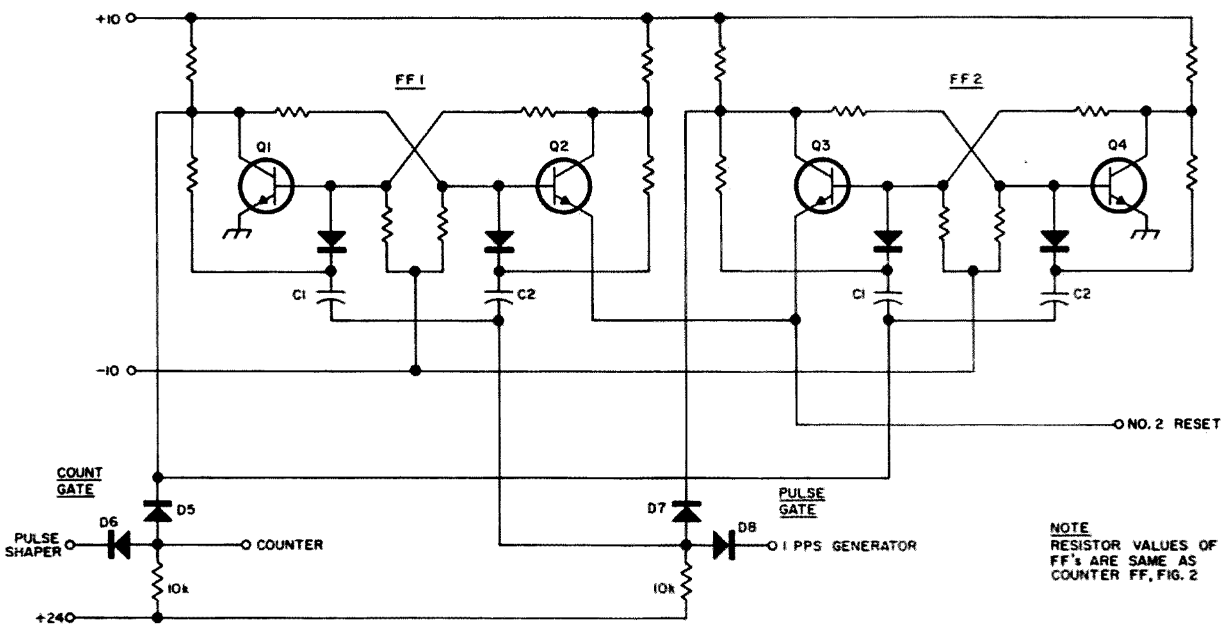


Fig. 5. Control flip flops and gates.

The x10 decade is built on a 3⅜" x 5⅞" board and mounts under the chassis on standoffs. The .01 μF input capacitors of the first stage of decade 1 presents a heavy load to the output of the x10 decade. Place a .001 μF capacitor in series with this output.

No difficulties should be experienced making the decades if components are tested prior to final assembly. Each decade can be considered as a single project, whereas the control panel may be separated into three, before combining them.

Some individuals may wish to substitute a double pole micro push switch for the relay. This may work satisfactorily but one must note that if the control flip-flops are grounded before those in the decades, an inaccurate count could result.

The timing generator utilizes the 60 hertz ac line frequency as a standard. This assumes the frequency is relatively stable. More refined methods can be employed but will add to the complexity, size and cost of the unit. Some difficulty was experienced at first in

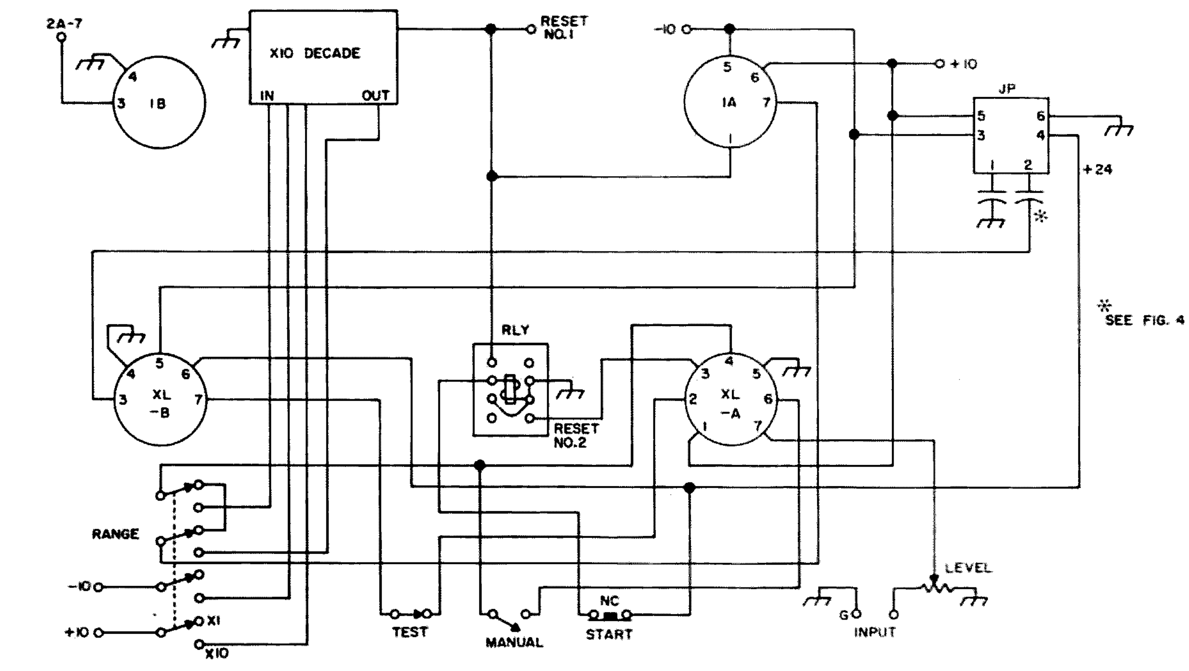


Fig. 6. Chassis wiring of the counter.

obtaining these frequency divisions. The problem appeared to be a matter of proper selection of component values and synchronization. The two 1 μF capacitors reduce the signal input to the sawtooth generator to about 17 V p-p. The signal, taken from T2, is not a true sine wave. For more information on UJT frequency dividers, refer to the G. E. Transistor Manual.

The 344 lamps are the most expensive item in the counter, though in lots of ten their price is competitive with other types that require a separate transformer supply, special driving transistors etc. There is a lower cost lamp available from one of the radio supply houses that you might consider as a substitute.

Due to differences in lamp and transistor characteristics and other factors, some lights may appear brighter than others. Exchanging driving transistors will contribute toward more uniform lighting conditions.

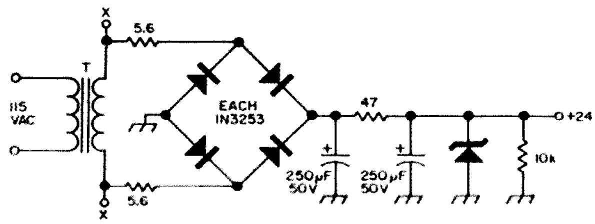
The power supply for the counter was adapted to this unit, serving a dual purpose and would be of little value to the reader. Voltage regulation of the −10 volt and +24 volt (if a relay is used) lines is recommended.

The following power requirements of the counter will permit the builder to design a supply to suit his personal preferences. The figures show only power drawn by the load.

- −10 volt at 280 mA idle °, to 420 mA, all lamps on.
- +10 volt at 30 mA, constant load.
- +24 volt at 45 mA, plus 38 mA for the relay.

° includes approximately 50 mA through the 3.3kΩ resistors.

When first turning on the counter warm up the power supply and charge the timing generator capacitors. This is done as follows: Use a signal input to the counter. Turn on test switch and let counter "free run" for a minute or so before taking a count. . . . K7UDL



NOTE
T = BURNSTEIN-APPLEBEE 18B506 115/24V, .3A
FOR 10V SUPPLY SEE TEXT
FOR "X-X" SEE FIG. 4

Fig. 7. 24 volt supply.

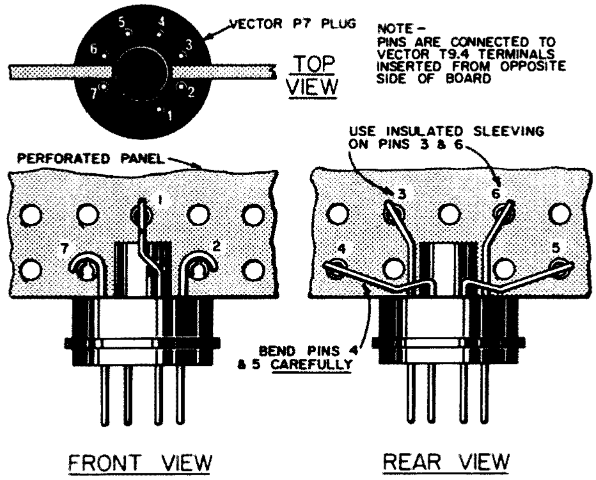


Fig. 8. Connections to the boards.

Parts List

C1, C2

Control FFs	.005 μF
Decade x10, FF1	220 pF
Decade 1, FF1	.01 μF
Others	470 pF

C3, C4

Control FFs	not used
Decade 4	150 pF
Others	47 pF

C5, C6

Decade x10	220 pF
Others	330 pF

R12, R13

Decades x10 & 1	100 kΩ
Others	1.5 MΩ to 2.2 MΩ

Transistors

Counter FFs	2N1305, 2N525
Control FFs	2N1304
Q3 (Driver)	2N43, 2N109, 2N408 etc.

Diodes 1N277, 1N457, 1N489 etc.
Relay 26vdc Allied Control KHJX-115 or similar
Other parts as shown in text or drawings.

Novice 80-meter transmitter

Bob Corbett W1JJL
46 Prospect Street
Torrington, Conn.

The Novice Pair

An inexpensive transmitter and receiver for the 80-meter Novice band

One of the first things a prospective Novice notices about ham equipment is its cost. Even inexpensive shortwave receivers cost over $50 and they're not very useful for hamming. Most specialized ham receivers cost far more. This may not seem like much to the established ham, but it's a huge amount to the young ham still in school. Yet it's not hard to make a useful ham receiver and transmitter at reasonable cost if you're willing to accept a few compromises in convenience and performance.

The simple receiver described in this article will cost about $12 if you buy all the parts—including the etched circuit board, battery, and case—new. All of the parts (except the circuit board) can be found in the Lafayette, Allied, WRL and similar catalogs. Careful shopping and a few parts from surplus equipment or old TV sets can reduce even this low price.

The receiver covers the part of the 80-meter band normally used for code, including the 3700 to 3750 MHz Novice band. It does a good job, too, and can easily receive stations hundreds of miles away with a simple antenna. It separates the signals surprisingly well, but naturally can't compare with the more expensive receivers. I've worked stations over 200 miles away with this receiver and its companion transmitter. Both are completely transistorized for low power drain, reliability, low cost, compactness and simplicity.

The receiver is an up-to-date version of a circuit very popular in the early days of hamming: a regenerative detector with an audio amplifier. The detector is quite sensitive and selective. It receives not only code signals but also SSB and AM phone. Anyone who uses a complex receiver normally would be pleasantly surprised at the performance of this simple receiver.

The transmitter is equally simple and uses only three inexpensive transistors. It costs about $16 complete except for the power supply. The power input (and consequently the power output) depends on the voltage supplied to it. Six volts input to the power terminals gives 1.2 watts total input. Power output is about half the input. Twelve volts gives 4 watts output; 24 volts, 10 watts; and 40 volts (the maximum safe voltage), 20 watts. The circuit of the transmitter is very simple. It's a crystal oscillator operating at 3725 MHz followed by a class C final amplifier. No heat sinks are required. There are only two controls: oscillator tuning and output tuning. Both simply need to be adjusted for maximum reading on the meter.

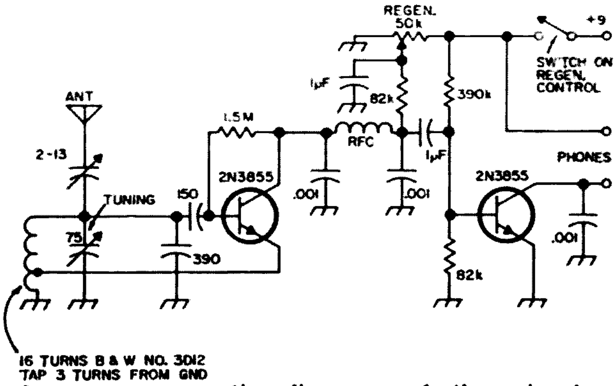
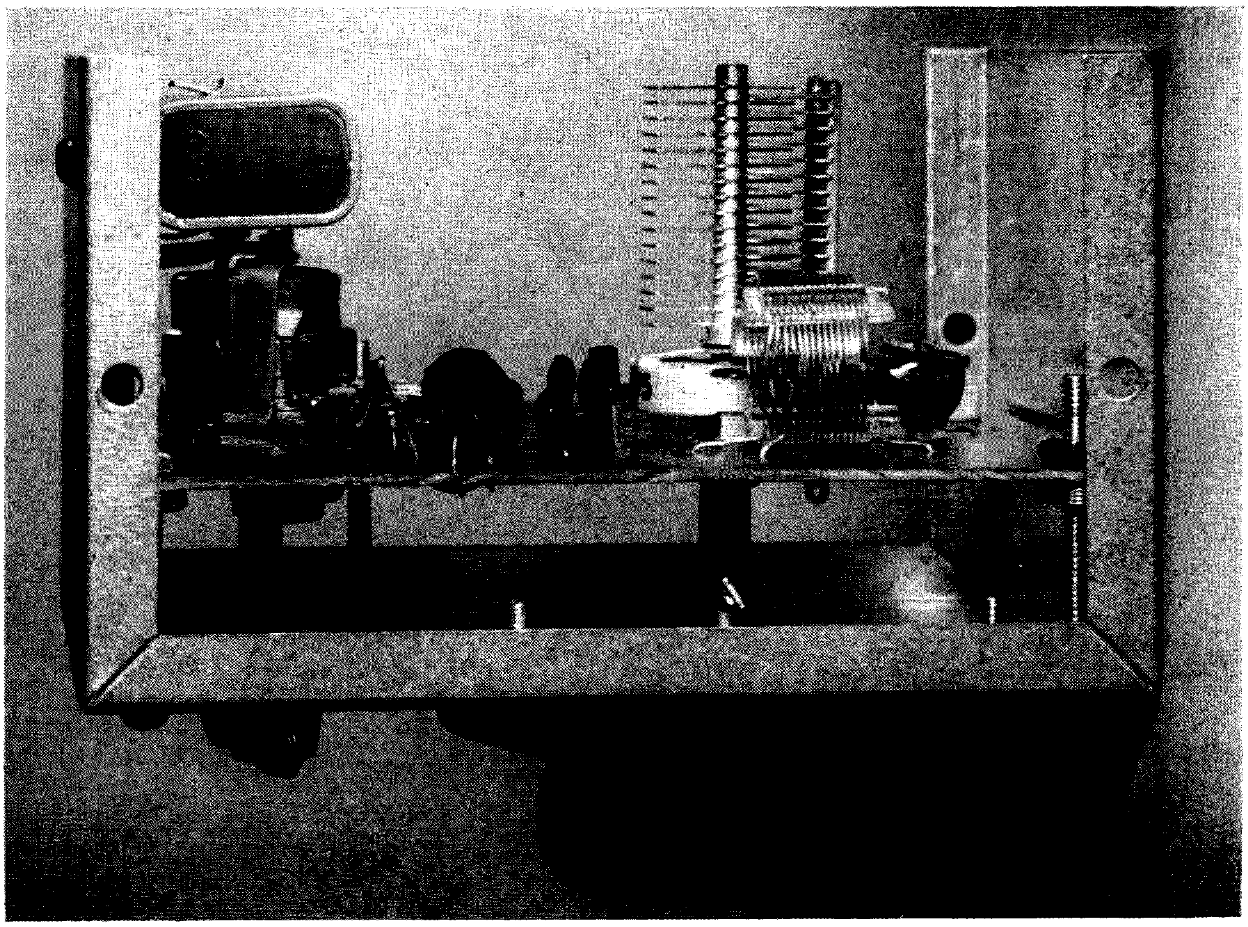
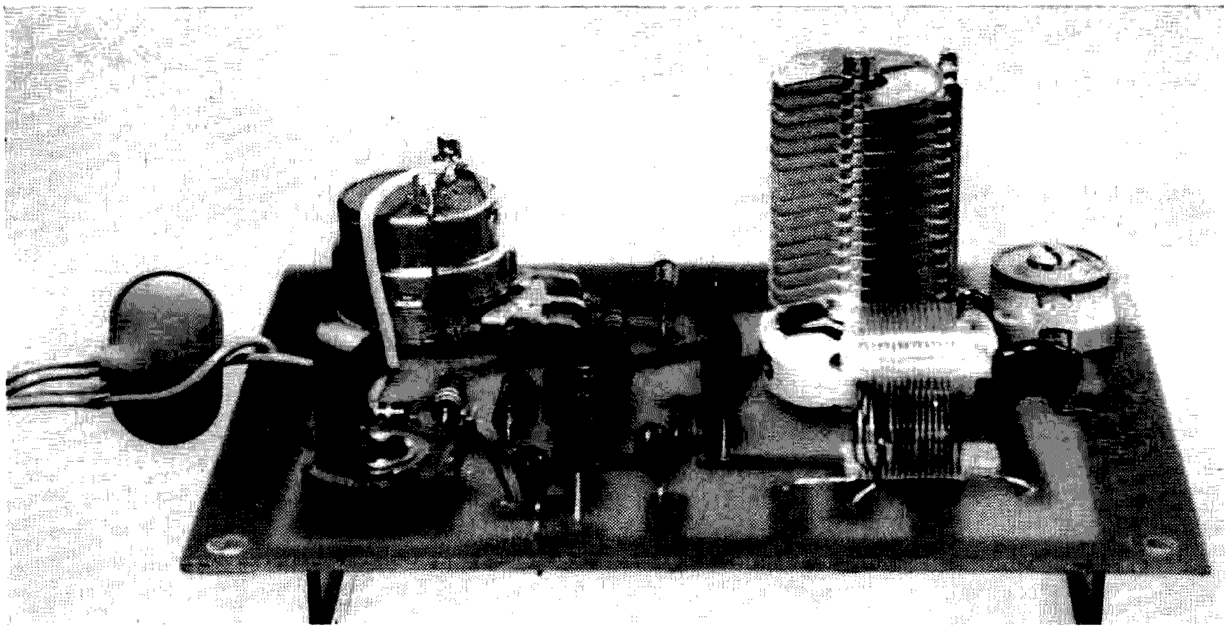


Fig. 1. Schematic diagram of the simple Novice receiver.

Building with etched circuits

These projects were designed for etched (printed) circuit board construction. You could build them on conventional chassis, on Vector board or Veroboard, or even on an old piece of wood, but the etched circuit boards have a number of advantages: they're neat, uniform, and almost error-free. The boards used in the receiver and transmitter can be bought already etched and ready to drill from the Harris Co., 56 E. Main Street, Torrington,


View of the transistor regenerative receiver mounted in its case. Notice how the board is mounted on long bolts with nuts holding the bolts and board in place. The vernier dial is mounted on the front panel with the template supplied with it.



Etched circuit board for the Novice transistor receiver before it's mounted in the case. The regeneration pot and phone jack are on the left, with the tuning capacitor, coil and antenna trimmer capacitor on the right.

Connecticut, for $2 each. If you buy both, the cost is only $3.50.

If you'd prefer, you can make your own board. It's neither hard nor expensive. You'll need copper-clad board, resist and etchant. These materials are available separately or in complete kits such as the Ami-Tron EZ-Etch Kit, which you can buy from Ami-Tron Associates, 12033 Otsego Street, North Hollywood, California. Both the individual parts and kits can be bought from many large dealers such as World Radio Labs, Allied and Lafayette. They come with complete instructions, but here's a quick explanation of what to do:

Place the template for the copper side of the board you want to make over the copper-clad board you want to prepare. Prick through each white circle to make a small hole in the copper. Then life off the template and use the holes as a guide to trace in the black lines with the resist according to the directions furnished. After you've put in all lines so that the board looks like the template, place the board in the etching solution as the directions specify. When all of the unwanted copper has been eaten off, wash the board thoroughly and clean off the resist with fine steel wool or household cleanser. Check the board carefully for short circuits or other possible problems.

Next drill the holes for the components. Use a sharp, high speed drill for best results. Most of the holes are for component leads.

Insert the components from the plain side of the board using the component layouts shown. Solder the wires quickly with a hot, clean iron and when the solder has hardened, clip off the extra wire sticking out on the copper side.

Final assembly

The photos tell most of the story on assembly of the units. After all parts are soldered on the boards, the boards are mounted in their cases with long machine screws and nuts.

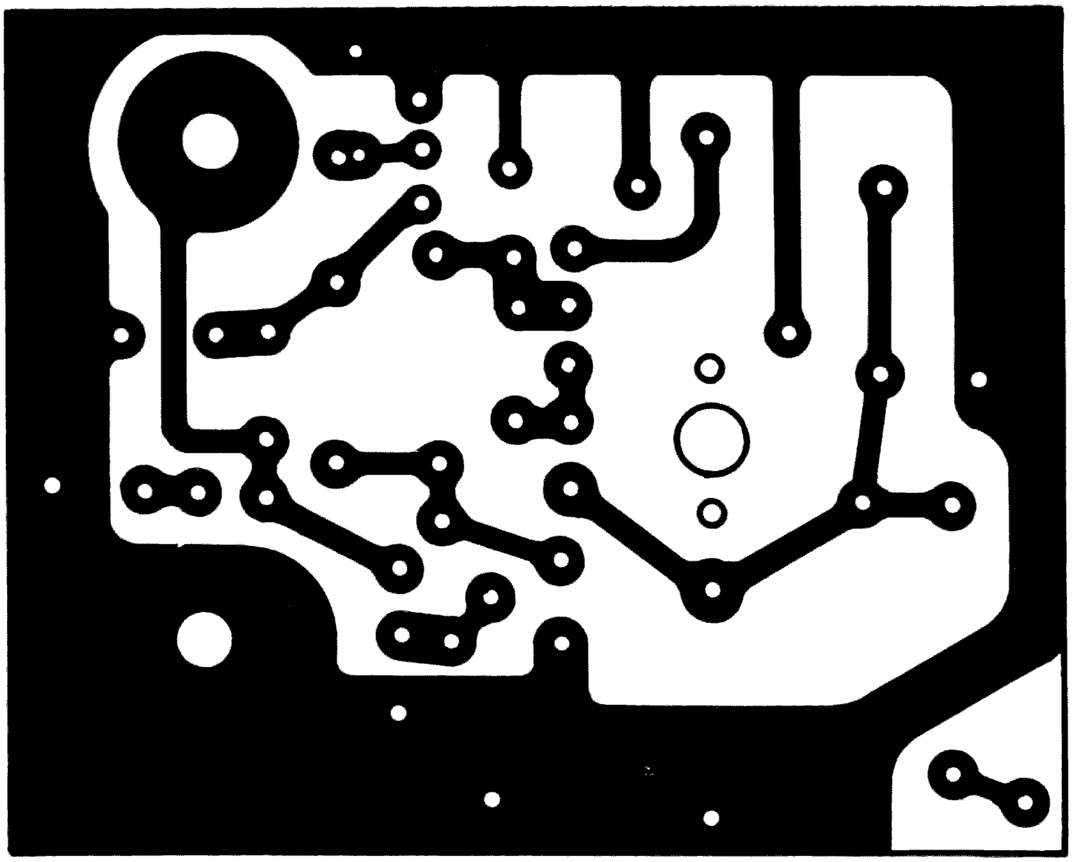
Very few parts are not on the boards. In the receiver, the vernier tuning dial is mounted using the template supplied with it. The battery is held in a clip made from a piece of aluminum or tinplate, and an antenna terminal is mounted on the side of the case. This terminal can be a simple feedthrough insulator or a phono or rf coax connector.

The transmitter is assembled similarly. The meter is mounted on the front panel, two insulated battery jacks on the back, and a coaxial jack on the side. There's no real need for a regular coax connector as a phono jack works as well.

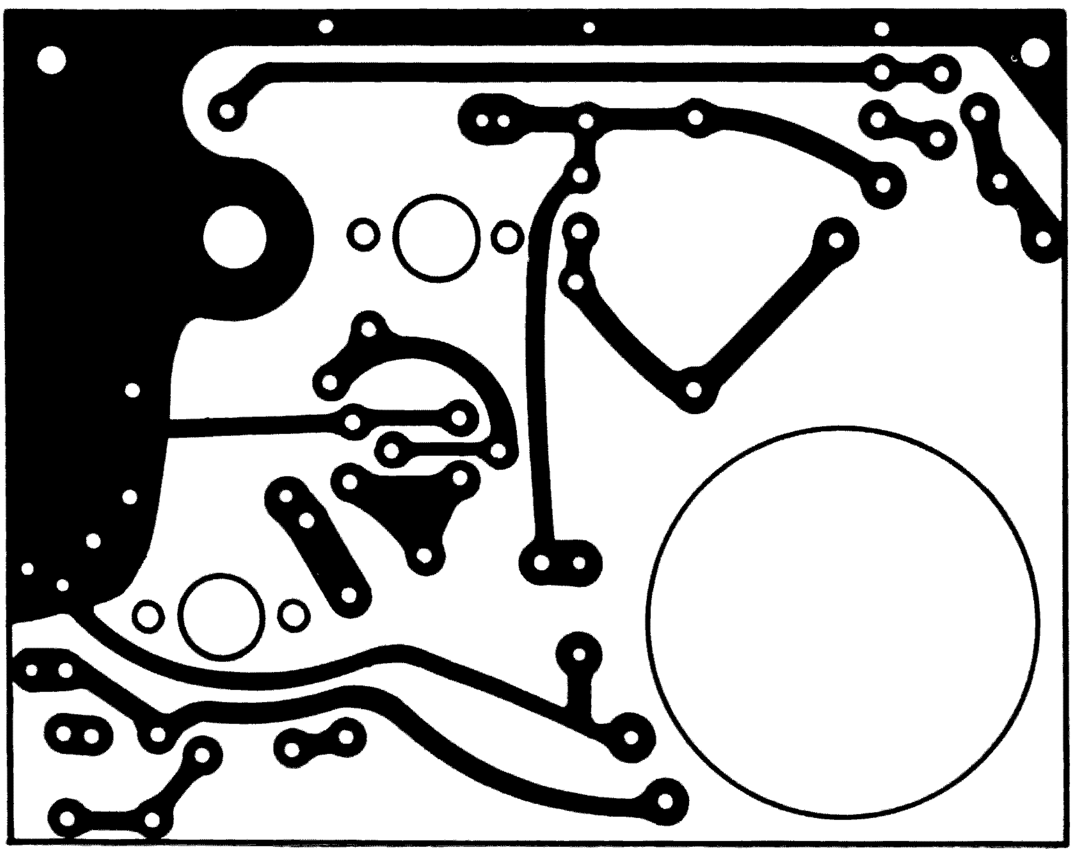
Receiver operation

The receiver is very simple to use. Use magnetic headphones of 500 to 10000 ohms impedance. Low impedance headphones for pocket transistor radios and crystal head-

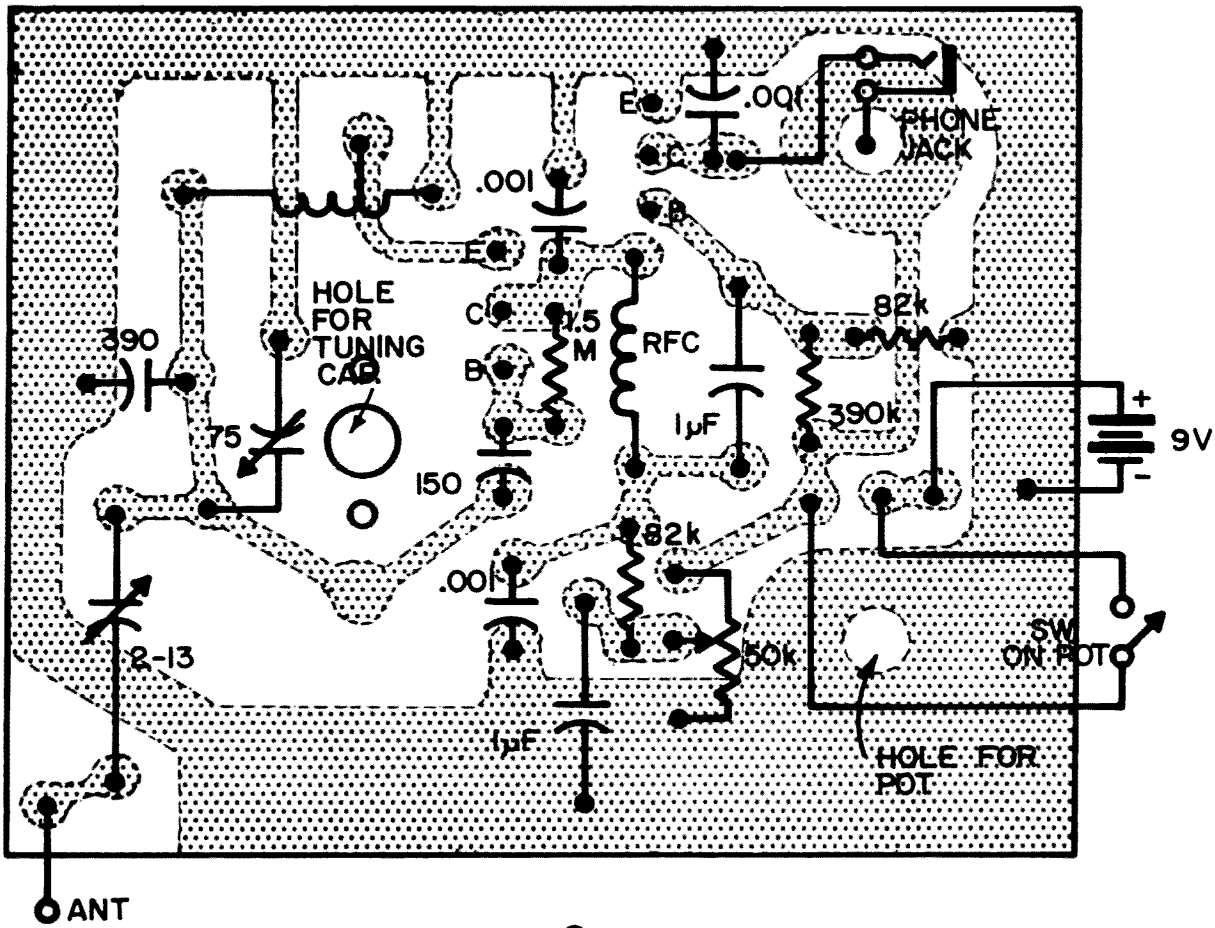
(Text continued on page 34)



Above: Copper conductor layout for the Novice receiver. Opposite: Component layout.



Above: Copper conductor layout for the Novice transmitter. Opposite: Component layout.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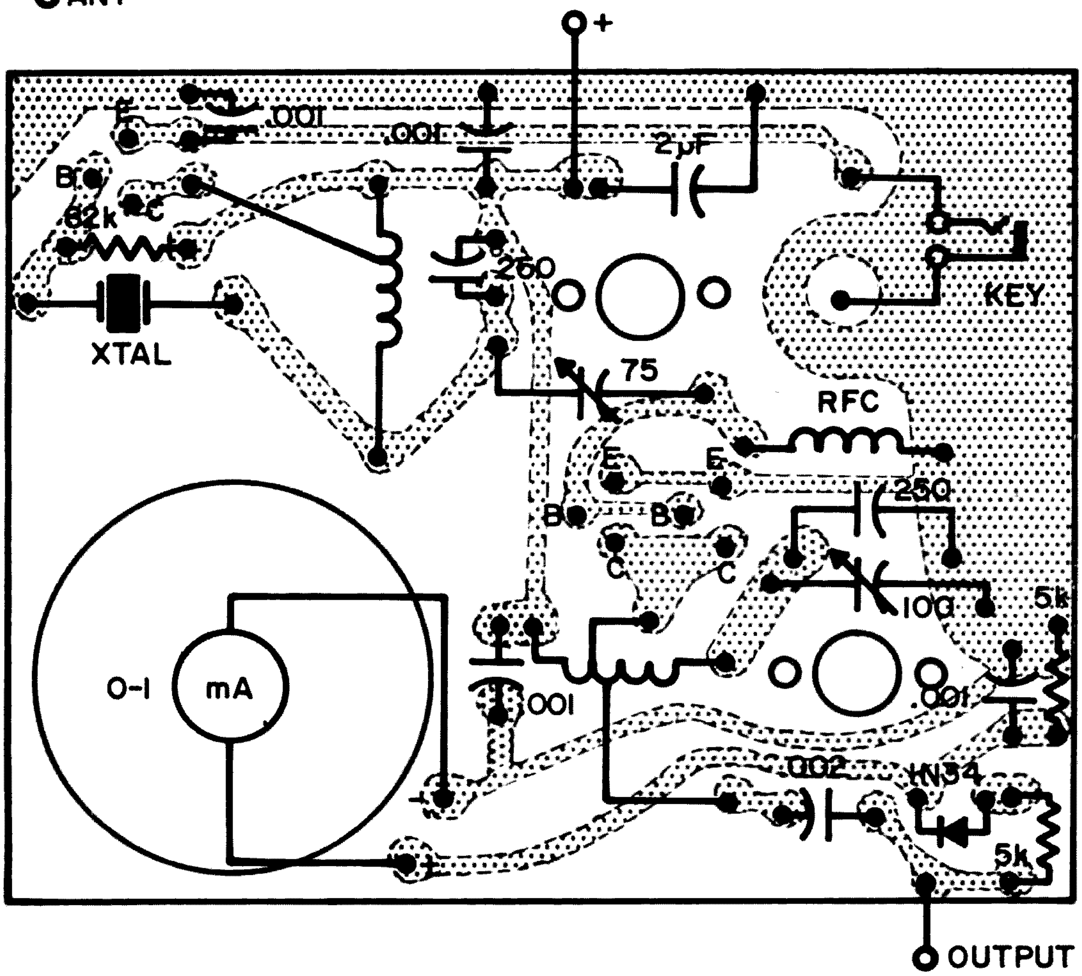
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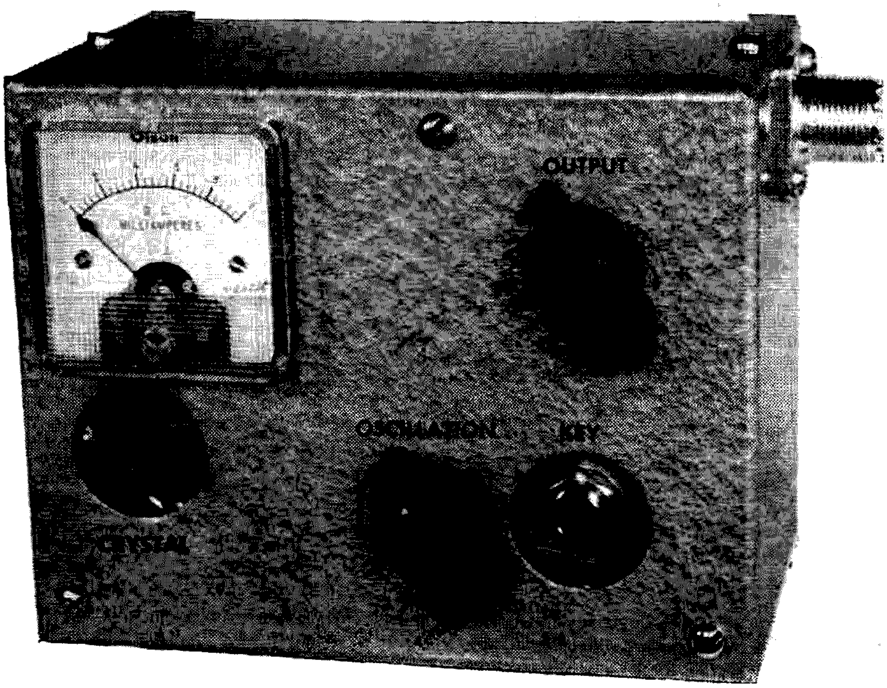
OUTPUT



Novice 80-meter receiver

phones won't work properly. A piece of wire either 30, 90 or 125 feet long makes an excellent antenna. Though it's not shown on the diagram, a good ground connected to the case is recommended for best results.

Turn on the receiver by twisting the regeneration control clockwise, past the switch click, until you hear a slight whistle. Tune around and you'll hear some stations. It's best to do this at night so that you'll be sure to hear plenty of them. Code stations are best received with the regeneration control set so that the detector barely oscillates and each dit and dah is loud and clear. You should hear many very slow stations near the center of the tuning range. These will be the Novice stations. If you have a crystal in the Novice band, you can locate your own signal by transmitting with your transmitter.

Voice stations on 80 meters are of two types: AM and SSB. AM is best received by setting the regeneration control so that the detector almost oscillates, and SSB can be tuned in much like the code stations, with the detector oscillating. If they're not tuned properly, SSB signals sound peculiar, almost like ducks quacking.

The small variable capacitor connected between the antenna and tuning coil can be any value from 2-13 to 3-40 pF. It's not critical, but should be varied if the receiver won't oscillate properly.

Novice Receiver Parts List

1	Premier 3"x4"x5" Minibox	$ 1.15
1	50 kilohm potentiometer with SPST switch	1.38
1	Length B&W 3012 Miniductor or Illumitronics 632T Air-Dux coil stock. ¾" diameter, 32 turns per inch. (only part used)	.62
1	5-75 pF variable capacitor, Hammarlund APC-75B	1.47
1	2.5 mH choke, National R-50	.42
2	1 μF/15 V electrolytic capacitors @ 29¢	.58
3	.001 μF disc capacitor @ 8¢	.24
2	82 kilohm/½ watt resistors @ 12¢	.24
1	390 kilohm/½ watt resistor	.12
1	1.5 megohm/½ watt resistor	.12
1	phone jack	.19
1	trimmer capacitor, 3-12 or 3-30 pF	.30
1	9 volt battery	.48
1	battery connector	.27
2	NPN high frequency transistors, GE 2N3855 @ 50¢ (or Motorola HEP-50, 79¢)	1.00
1	2-⅞" vernier dial	1.39
2	knobs @ 12¢	.24
1	antenna connector (pin jack)	.15
Total		$10.36

Printed circuit board (optional) $2.00

Novice Transmitter Parts List

1	3"x4"x5" Minibox	$ 1.15
1	75 pF variable capacitor, Hammarlund APC-75B	1.47
1	100 pF variable capacitor, Hammarlund APC-100B	1.67
1	length B&W 3012 Miniductor (use part of receiver coil stock)	.62
1	length B&W 3015 Miniductor coil stock, 1" dia. turns per inch	.16 .68
3	RCA 2N2270 NPN transistors @ $1.16	3.48
2	5 kilohm/½ watt resistors @ 12¢	.24
1	82 kilohm/½ watt resistor	.12
4	.001 μF disc capacitor @ 8¢	.32
1	2 μF/50 volt electrolytic capacitor	.54
1	2.5 mH choke, National R-50	.42
1	.002 μF disc capacitors	.08
2	250 pF ceramic capacitors @ 8¢	.16
1	crystal socket for FT-243 crystals	.36
1	1 mA meter	2.95
1	phone jack for key	.19
1	coax connector, SO-239 is 48¢. RCA phono jack	.15
2	knobs	.24
2	battery jacks (binding posts) @ 25¢	.50
Total		$15.34

Printed circuit board (optional) is $2.00

Transmitter operation

The transmitter is almost as easy to use as the receiver. Connect a resonant antenna to the antenna jack. A suitable antenna is a half wave dipole (125 feet long and split in the middle by an insulator) fed by 50-ohm coaxial cable such as RG-58. Attach a 6 to 40 volt dc power supply good for up to 500 mA (half an ampere) to the power terminals, being careful to connect the positive and negative leads properly. Plug a crystal in the 80-meter Novice band (between 3705 and 3745 kHz), which you can buy from many 73 advertisers, in the crystal jack and a standard key in the key jack. Push down the key and adjust the two controls quickly for maximum meter reading and you're on the air!

A suitable power supply is easy to build from inexpensive parts available from many 73 advertisers such as John Meshna. See the article on transistor power supplies by Hank Olson W6GXN in this issue for more information on low voltage power supplies.

The easiest way to use the transmitter and receiver together is with separate antennas. The transmitting antenna must be resonant at the frequency of operation, but the receiving antenna isn't so critical.

Have fun with your receiver and transmitter. When you move up to more complicated equipment, you'll find this pair fun for contests and portable operation.

. . . W1JJL

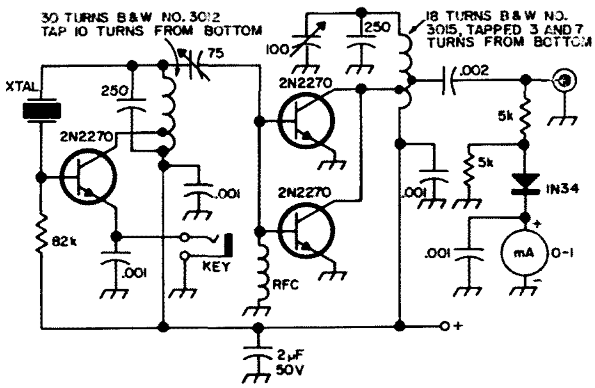
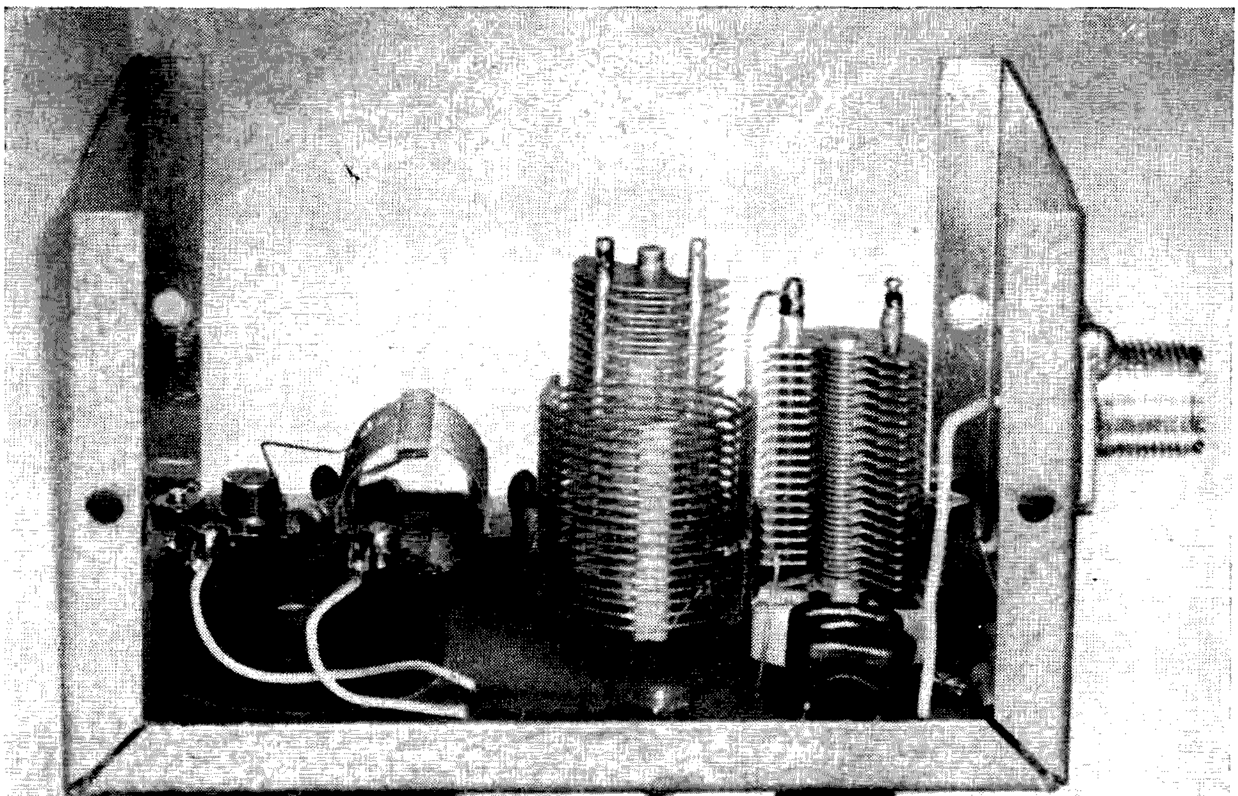


Fig. 2. Schematic of the simple Novice transmitter.



Top view of the interior of the Novice transistor transmitter. The etched circuit board is held away from the aluminum cabinet by a few extra nuts screwed on the mounting bolts. The meter and oscillator can be seen at the left, with the oscillator tuning capacitor and final coil in the center of the unit. The capacitor on the right is for tuning the final tank circuit. The coax connector is mounted on the left of the cabinet.

Henry Olson W6GXN
3780 Starr King Circle
Palo Alto, California

A Laboratory-Type Power Supply

This power supply is ideal for the ham who experiments with transistors. It features variable voltage output, current limiting, excellent regulation and low impedance.

A typical laboratory power-supply will have variable voltage output, low internal impedance, good voltage regulation with a variety of loads, freedom from output changes with line-voltage fluctuations, adjustable current limiting, low ripple and noise voltage in the output, and accurate metering of output voltage and current. Clearly all these features are not needed for *every* system, but several of them will be suited to each particular circuit under test. Having tested the circuit with our laboratory supply, we can then vary the supply voltage around to test the circuit sensitivity to input voltage change. We can also, put resist-

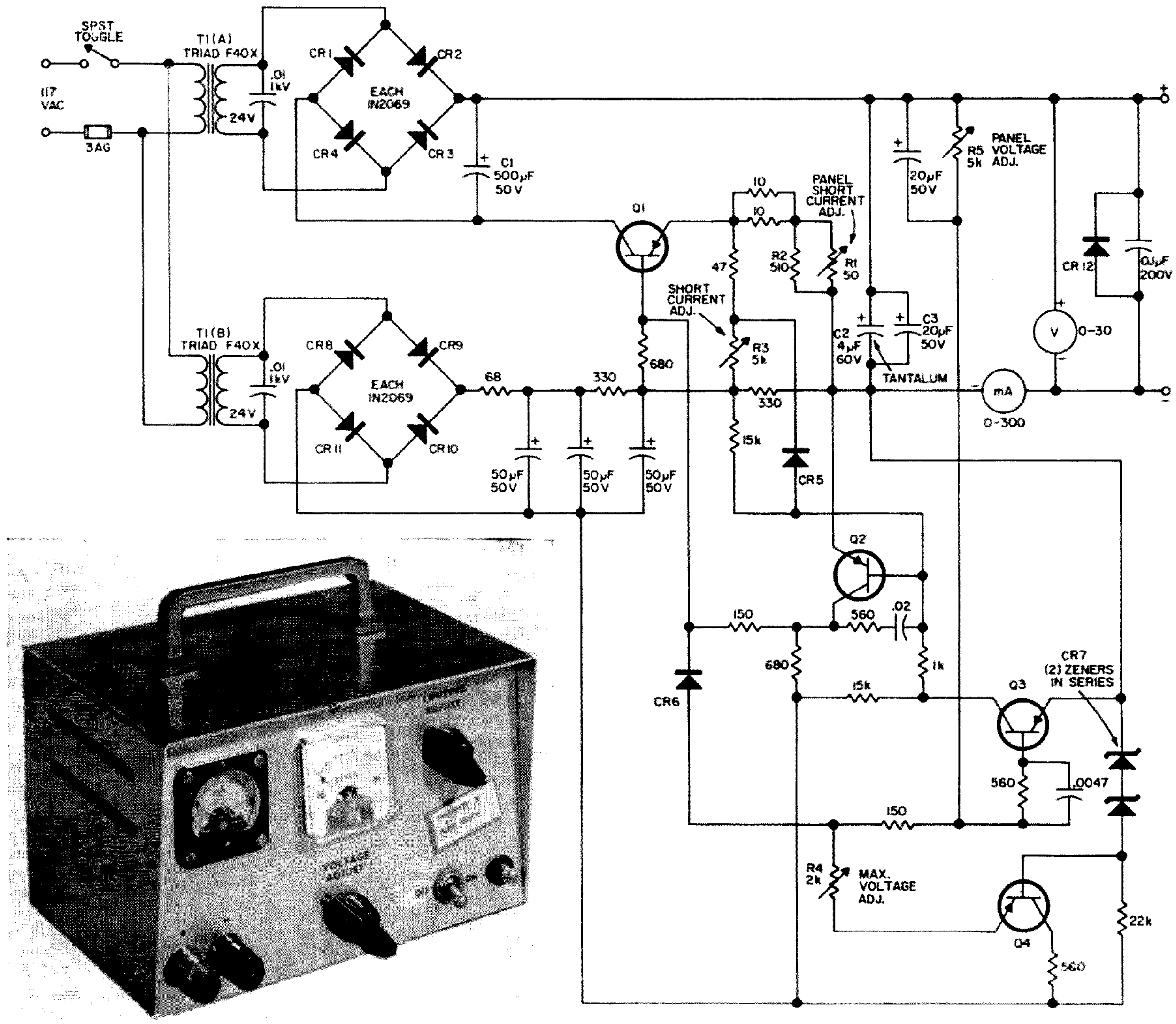


Fig. 1. Laboratory-type power supply. Q1 is a 2N375 or 2N1542A; Q2, Q3 and Q4, 2N508; CR1, 2, 3, 4, 8, 9, 10, 11, 12, 1N4002 or 1N2069; CR5 and CR6, HB5 or FD1135; CR7, 1N755 or two 1N468's in series.

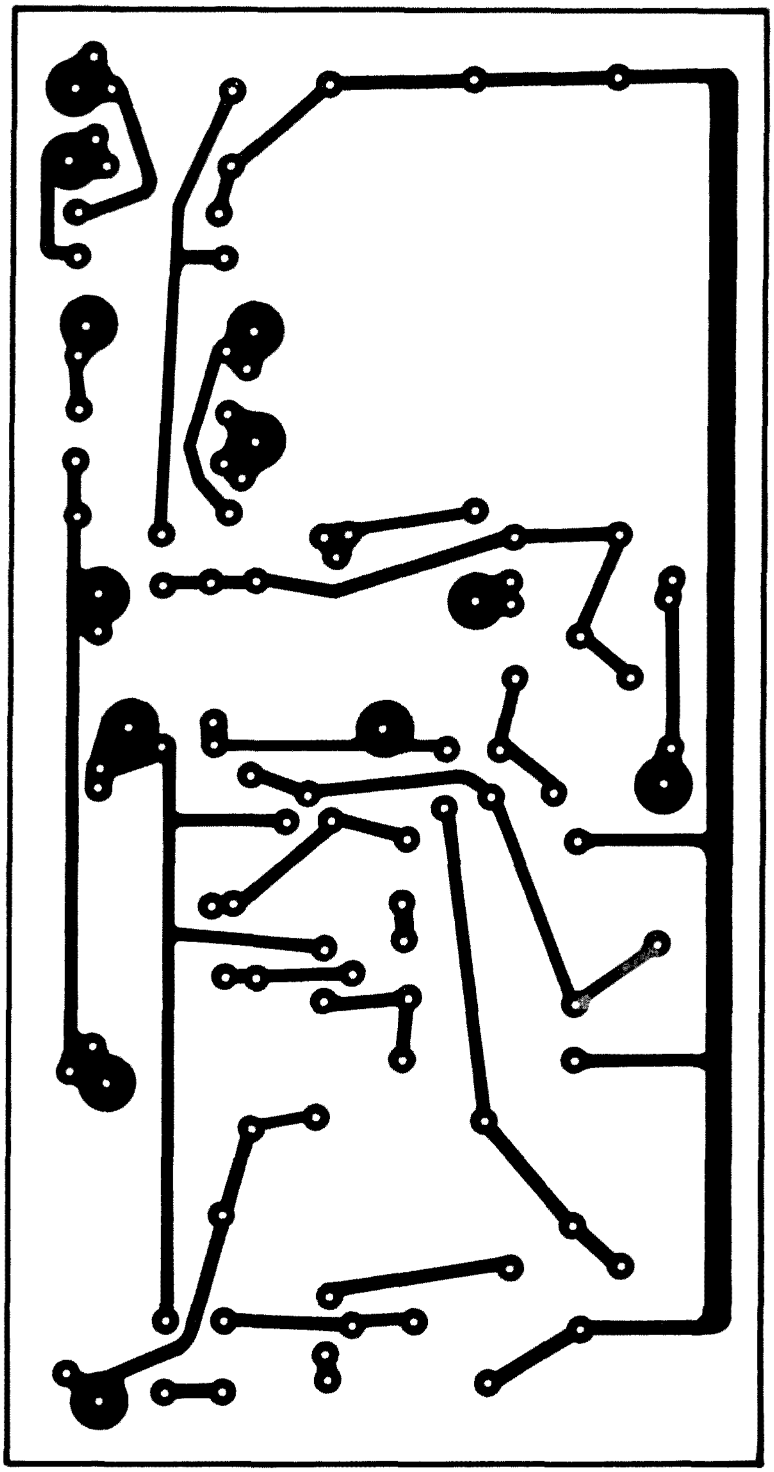


Fig. 2. Circuit board layout for the laboratory power supply shown in Fig. 1. This board is available from the Harris Co., 56 E. Main Street, Torrington, Conn., for $2.

ors in series with the lab power-supply to check the circuit dependence on the power-supply internal impedance (has your high gain audio amplifier ever 'motorboated'?)

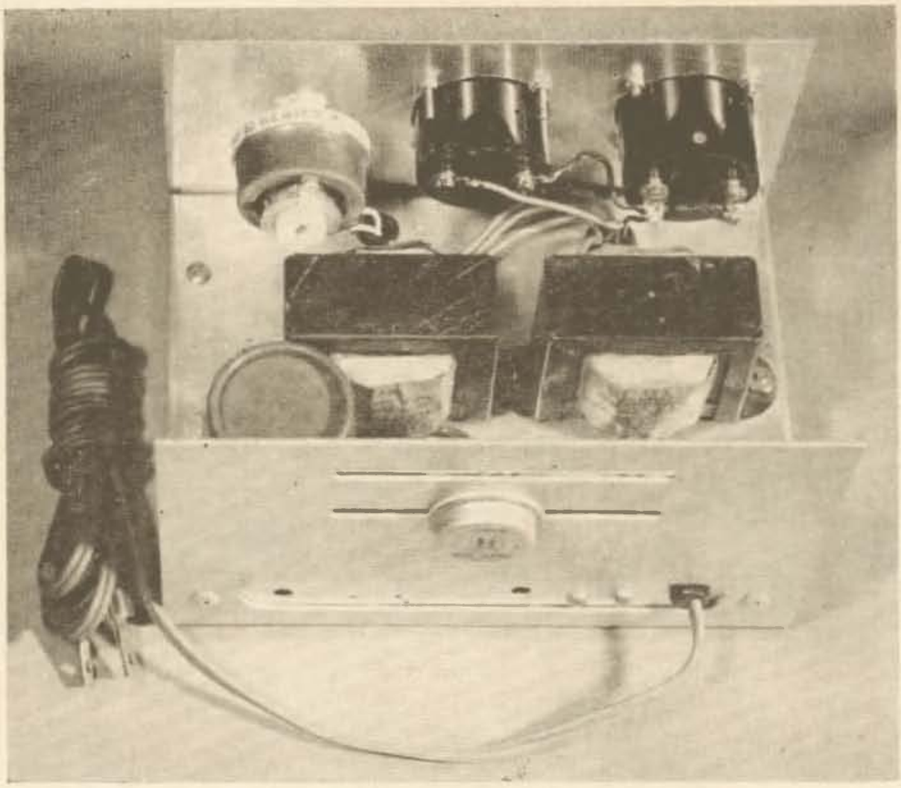
Then with complete knowledge of the voltage, current, internal impedance, and voltage stability requirements, we can proceed to build a simpler power-supply for our circuit.

One very satisfactory laboratory power-supply has been described in the *Handbook of Selected Semiconductor Circuits.*[1] Although not so identified, this circuit appears to be that of an early model of the Hewlett-Packard 721. The laboratory power-supply circuit, as modified to make it possible to build with readily obtainable parts, is shown in **Fig. 1.** As presented in the *Handbook of Selected Semiconductor Circuits,* it had several special components in it, and equivalents had to be found for these. The power transformer T_1 was replaced by two Triad F40X's, both operated in the full-wave bridge configuration. The series of three resistors and a switch, comprising the current-limiting selector, was replaced with a 50-Ω rheostat having a 510-Ω fixed resistor across it, which gives continuous current-limiting adjustment. Also, the meter switching and associated resistors were done away with, and separate meters used. CR5 and CR6 were originally of a type not readily available and can be replaced by Hoffman HB5 silicon diodes, or any similar general purpose silicon types. CR7, another obscure type, was replaced with either two 1N468's or one 1N755 (but nearly *any* zener of about 7 volts will do). The series transistor (Q1) is listed as a 2N375, but a number of other 80 volt power transistors have been used in its stead, including the 2N174 and 2N1542.

Most of the circuitry is laid out in a simple etched circuit board as shown in **Figs. 2** and 3, and so wiring is very fast. The supply is housed in a standard LMB-W1A cabinet. The series regulator (power) transistor is heat-sink mounted on the back plate (with a mica insulator, of course).

One of the units the author built was made entirely of MARS-supplied semi-conductors; a large percentage of the other small components were also MARS-supplied.

A silicon rectifier was added across the out-



Top-rear view of the lab supply with cover removed. A Triad F45X has been substituted for one of the F40X transformers.

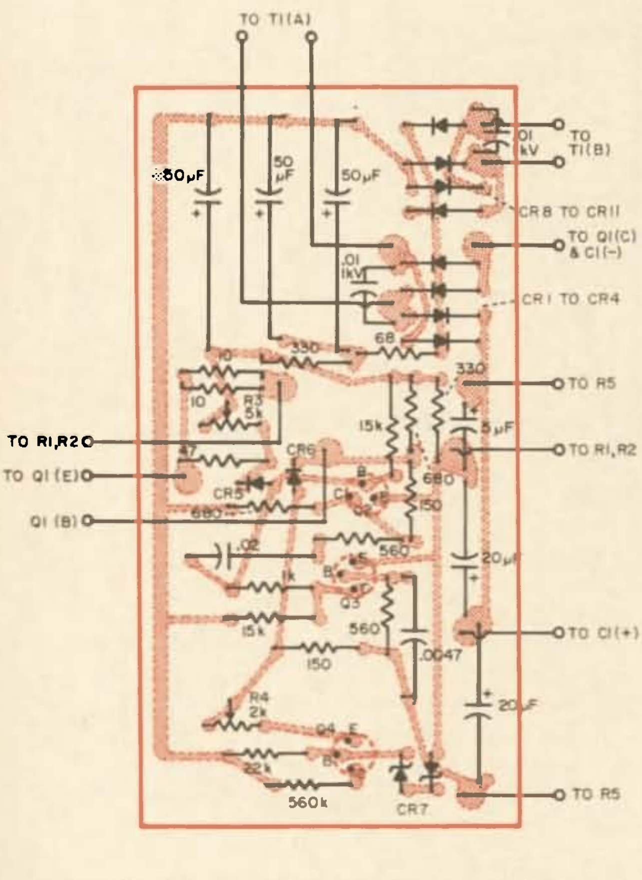


Fig. 3. Component side of the circuit board shown in Fig. 2.

put of the supply in addition to the 0.1 µF capacitor to help kill any transients (from the equipment being run by the supply) that are opposite to the supply polarity.

The meters used are the inexpensive Japanese-made miniature types available under many U.S. names including "Calrad", "Monarch", and "Lafayette". Their accuracy seems adequate for this application.

One will note that C1 and C2 are in parallel. The original purpose of this apparent duplication was to assure that the 20-µF electrolytic was a low impedance for low frequencies, and the 5-µF tantalytic was a low impedance for higher frequencies. However, if one has a 25-µF to 50-µF tantalytic, the single unit will do by itself.

When the power supply is finished, just plug it in, adjust the two screw-drive adjustments: "max. voltage adj." and "short circuit current adj." for the 0-30 V range and 25 to 225 mA range of the front-panel controls.

The author wishes to thank Hewlett-Packard for permission to use Fig. 1. I'd also like to thank Curt Roche, W6ZMW, for his helpful discussions in preparing this manuscript.

. . . W6GXN

[1]Sherrill, P. N., "Small Lab Supply with Current Limiting," in *A Handbook of Selected Semiconductor Circuits* (NObsr 73231); Available from U. S. Govt. Printing Office.

Merritt Franken WA6JNI
3714 Mount View Ave.
Studio City, Calif.

QRZed the YL

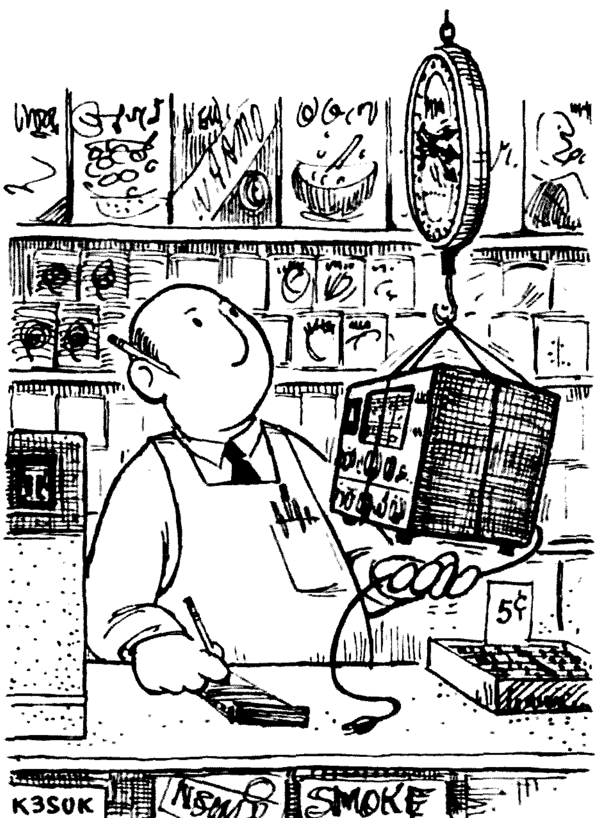
or, Don't Ever Let Your Wife Become a Ham

Lotsa times, in the course of a QSO, I mention to the op I'm working that my wife is also a ham. Her name, I tell him, is Charlotte and her call is WA6JNO, ex-WA2AVB.

The reaction is invariably the same. The other station will say something like, "Boy are you lucky. Sharing the hobby with the XYL. That sure must be great. Bet she never gives you a hard time about getting a new piece of gear or putting up an antenna farm."

Or words to that effect.

Well, fellas, I got words for you. Don't let your wife become a ham. Belt her a few first; threaten to get a divorce; tell her *you'll* go home to mother. Tell her anything. Give her Arpege, if you have to, but buddy, don't let her become a ham.



Drawing by K3SUK.

You will admit a grocery is a kooky place to buy ham gear . . .

Think I'm kidding? Let me reconstruct and you'll see I never knew when I had a good thing going, when my little woman didn't know a QSY from a Mandarin's queue.

Ten-twelve years ago the ham bug bit me. Actually, it was the second infection. The first time was in 1941 and while I was working toward getting a ticket the War came along and that was that. The second time, though, there was this new FCC deal called a Technician's ticket. Hooray, the five wpm cw was easy and I started studying dits, dahs and theory.

Meanwhile, Danny, a friend of mine in New York City where we were then living, who runs a radio and TV repair shop and who knew of my interest in the hobby, told me of a chap down the street who had some ham gear for sale. This man was a grocer and my friend said he had a complete station for sale. I go over and look at the goodies and wind up buying his NC125. He also had a Harvey Wells TBS50D, but I held off on that.

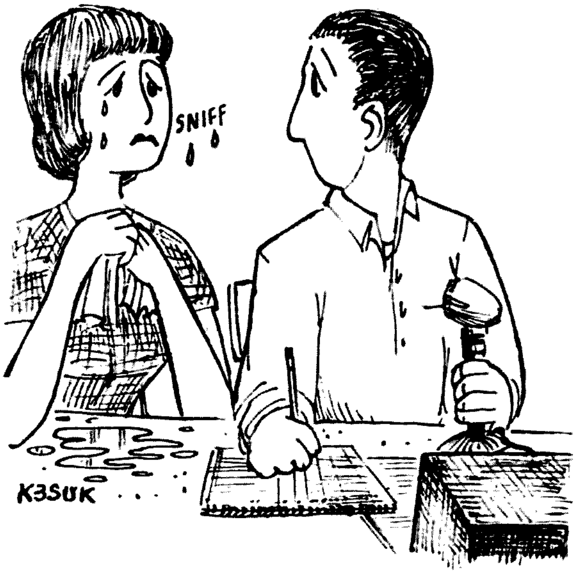
So I trudge on home, set up the NC125, hang a wire out the window and start listening. Man, I sat there enthralled; I had the world at my finger tips. Without doubt this was the greatest thing since sliced bread. 'Bout an hour or so later the little woman comes home and, of course, she hears this startling short wave stuff.

"What's that?" she asked, and I told her.

"How much was it?" was the next question.

I looked her smack dab in the eyes and said, oh so casually, "It was $25."

And she believed me. She didn't question me once. She believed me; she didn't see my fingers crossed behind my back and still less



"Nothing," she said, "It's so wonderful."

could she see the large twinges of conscience that kept stabbing my innards.

So, I kept studying and kept listening and one day I paid another visit to the grocer. (You will admit a grocery is a kooky place to buy ham gear). We talked about the Harvey Wells and the special power supply he'd built with big fat oil-filled condensers and a foot switch to go from high to low power and that if I got a Tech ticket it would work on six meters and I bought it. Had no ticket yet but I bought it and put it in the trunk of the car and covered it with a blanket, and took the power supply over to Danny's and had him hold it for me.

Then I got my ticket. I was K2KEH.

Happened the next night was my helpmeet's bridge night so while she was out, I brought up the Harvey Wells and the monster power supply and a six meter converter I'd just happened to acquire and put them all together. I still had no six meter beam and no mike but that stuff looked real pretty and I was sitting there admiring it when Charlotte came home.

"What's that?" she asked.

"A transmitter," I said.

"Does it work?"

"Well, I hope so. I won't know until I get an antenna tomorrow."

"How much was the transmitter?" she asked.

And I looked her smack dab in the eyes and answered, "It was $25."

"Ok," she said, "I just don't want you to spend a lot of money on that silly stuff. How much will your antenna cost?"

"Not much," I said. "Few bucks. Depends on what kind I get." I didn't say anything about co-ax cable or a co-ax relay or a microphone and I double sure as hell didn't say what six meters would probably do to TV reception in a Manhattan apartment house.

Two days later my station was lashed together and of course the antenna, rotator, cable, low pass filter, mike and all cost only $25. I told Charlotte that, scared as I was of talking into a mike, I was gonna try. She came into the shack (once a nice, pleasant den type room but now a nice pleasant mess), sat down in a chair behind me and I called CQ.

And a station came back to me and I'll remember his call and name, K2YCB, Carl, long as I live. With my voice shaking with mike fright I talked and had my first QSO. Then I signed, and full of pride, turned around to look at my wife.

She was crying. She was sobbing. Tears streamed down her face.

"What's the matter?" I asked.

"Nothing," she said. "It's so wonderful. My husband sits here and talks into that thing and a man from New Jersey comes back and it's wonderful. It's thrilling. Do more."

And stupid me, I never saw the danger signs.

Few days later I came home and I find Charlotte listening to my receiver. NC125, did you say? No sir. I had traded that. I didn't like the single conversion and the outboard converter. The receiver was an HQ110.

And buster, that HQ110 also cost $25. Brand new, it only cost $25.

But what I started to say was that first I found Charlotte listening and then I found her studying the license manual and other books I had bought and then I found her using the code oscillator and then I was informed, one night, that she'd enrolled in a ham course at the Delehanty Institute. Three nights a week.

Now if you're not from New York you probably don't know about Delehanty. It's an old, old institution. It's in one of New York City's most unprepossessing semi-slum areas, near the Bowery. The dark, dingy section gives you the feeling that any man walking along the street at night is a cutpurse. Delehanty's is best known for training firemen and police and teaching them judo and all like that. It just didn't strike me as a place I liked for my wife to be at come nightfall or any other time.

And my wife is a student there. At night. But she goes, and I drive down to pick her up, and whammo, she has a general ticket and I'm still a Tech. Not only is she a general

but she is now a reader of QST and CQ and so she knows all about this phony "It was only $25" stuff. Need I describe what happened when that bomb burst?

Well, there's not too much more to tell, but what there is is sad indeed, men. For weeks and weeks and weeks I come home. No dinner. Why no dinner? Because the little woman has been standing over a hot rig instead of a hot stove. On top of that, my pride is lower than a snail's hangnail; my wife's a GENERAL and I'm a Tech. In time I rectified that and got my general, but this leads to another interesting development. I hear a nice hunk of DX and join the pile-up and call for the DX station. Does he come back? 'Course not. So the XYL calls him—and he comes right back—they always do when they hear a YL's voice. They always say, "QRZed the YL. QRZed the YL." Score another hunk of DX for the YL—my XYL, to be specific.

Eventually, things settle down. We work it out so that Charl operates days—just so long as I get a nice hot dinner preceded by a nice cold 807 and none of this TV dinner stuff. I operate evenings and week-ends. As an extra added precaution I work CW and wear cans. Since she can't hear the CW monitor because I'm wearing the cans we don't get into this routine where, if DX does come along, she'll come in and inquire sweetly, "Want me to give him a call, darling?"

And the Drake TR4 and the Heath compact linear and the TO Keyer and the Waters dummy load and the tower and the beam and the rotor and the 40 and 75 dipole only cost $25. You don't believe me? Ask my wife.

. . . WA6JNI

Howard Pyle W7OE
3434-74th Avenue, S.E.
Mercer Island, Wash.

Climbing the Novice Ladder

Part I: The Ham Bug Bites

"Larry, I'm sold. I've been to three meetings of your club now and I've been reading up a bit on ham radio. There's a heck of a lot that's way over my head now but I think I can catch on; how do I get started?" Joe Blake was serious as he put the question to his recently found friendly ham on their way home from club.

"Well Joe, *wanting* to be a ham is half the battle. You like the club, you've met some nice guys and a few gals, or 'YL's' as the hams call 'em, meaning young ladies. Next meeting you'd better bring your dollar entrance fee and get signed up as an associate member. When you get your Novice license you'll be entitled to full membership; it'll cost you another buck then which will cover your club dues for a year and you'll get the club paper every month. After that, a dollar a year keeps you an active member." Larry Saunders himself was a relatively recent newcomer to the ham fraternity; his General class license was barely nine months old but he had won his way up through the Novice ranks and was now accepted as a full-fledged member of the 'charmed circle.' An electrical engineering sophomore at State College, his interest in amateur radio had stemmed from occasional visits to the ham stations of a number of his fraternity brothers and he had, like Joe, followed this by attendance at several meetings of the local ham club. Remembering the friendly college ham who had guided him through the early pit-falls, Larry too decided to be a 'nice guy' and take Joe under his wing. After all the kid was a likable chap . . . a senior in high school who was top man in his science class and now showed an increasingly eager interest in becoming a ham.

Follow Joe Blake monthly in these pages as he progresses from a raw apprenticeship in ham radio, through the various stages leading to successful completion of his Novice class license examination.

They stopped at the malt shop for a bedtime snack and, in a quiet corner booth, Larry gave Joe a bit of background on his own early days as a radio amateur beginner. "The first thing you'll have to do Joe," Larry concluded "is what most guys consider the hardest . . . learn the radiotelegraph code. It really isn't hard at all once you get your teeth in it. You'll find that in only a few weeks you'll be saying words in radio code that it took you two or three years to learn to say as a baby!"

"But Larry," Joe replied, "how come I have to learn the code? Most of the hams I've visited have just talked normally into a microphone; that's what I'd like to do too! I don't know whether I want to learn to telegraph or not."

"Let's face it Joe," Larry returned, "whether it appeals to you at this time or not, learning the radio code is a must if you're going to be a licensed ham and expect to talk to others on the air. And to do that, Federal law says that you must have a license and that means answering a few simple questions in a written examination and passing a radio tele-

graph code test at five words a minute. Don't let it worry you though . . . at that speed you can almost take a nap between letters." Thus Joe was introduced to his first hurdle; while Larry made it seem easy, Joe wondered with a bit of misgiving, just how easy he was going to find it. Thus pondering, Joe was suddenly brought back to the fascination of hamdom by an exciting sugestion from Larry.

"Say Joe, tell you what. One of the best ways to get a start in ham radio is to know a real 'old timer,' visit him often and listen to his suggestions and advice. We're lucky in this town for we have an old guy here who's been a ham for more than fifty years . . . he must be close to seventy by now . . . and he really knows the ropes. While he's hammed all that time just for pleasure, he's made his living in the radio game for that long also! He's been a commercial radio operator both at sea and ashore, a Navy operator, held a lot of government radio jobs; he's been just about everywhere and done about everything in radio. Nice part is that he's worked with a lot of young fellows all his life and actually likes to give 'em a hand if they're serious about wanting to be hams. And boy . . . the stories he can tell and they're all true too! Here's what we'll do; tomorrow's Saturday and if you've got nothing particular to do what say we run over and see old 'FN' in the morning?"

Joe *really* sparked on that one; "Gee Larry, that would be great . . . I'd sure like to."

"OK lad, I'll pick you up about ten thirty tomorrow then" and with that they paid their tab at the malt shop and putted homeward in Larry's old jalopy.

At a little after ten the following morning the squeal of worn brake bands on Larry's old Chevy announced his arrival. Joe, who'd been eagerly awaiting the planned excursion, dashed from the house, jumped in the heap of bolts and nuts and they were off. During the seven mile trip Joe sprang a question which had been puzzling him since last night. "Larry, you call this old guy 'FN' . . . I don't get it . . . that's not his *name* surely?"

"Ha," Larry came back, "I was wondering when you'd get around to that! No, his name is Dwight Mansfield . . . 'FN' is what he prefers to be called though and I'll tell you why. Seems that almost since the Morse telegraph was invented, telegraph operators were required to sign a 'receipt' so to speak, for every telegram they received over the wires. You can't sign your name with a telegraph key like you would with a pen or pencil . . . you had to send every letter of your name in the telegraph code. This got to be pretty much of a time-consuming chore and it wasn't long before operators began to use their initials which shortened it a lot. A bit of confusion sometimes resulted though where two or more operators working the same wires happened to have the same initials. Where this occurred, one or the other would simply choose an arbitrary letter or two which would serve to distinguish him as the one receiving a message. This letter group was known as their 'sine,' the spelling being simply a variation of the word 'sign.' It took fewer dots and dashes to say 'sine' than to use the correct spelling when you asked the operator at the other end for a receipt. The use of these sines soon became standard telegraph practice and when 'wireless' telegraphy, or 'radio' as we now call it came along, many Morse telegraphers were recruited for this new field; invariably they took their sines along with them. So Dwight . . . oh yes, among his many accomplishments he too had been a pioneer Morse telegrapher . . . followed suit and carried 'FN' along to the new communication field that he had chosen . . . get the picture now? Most hams don't have or use sines now."

"Yes, but Larry, how come Dwight took 'FN' as his sine . . . they're not his initials?"

"Gosh Joe, you could fool me . . . never thought about it; let's ask him." And so saying Larry skillfully wrestled the wheel of 'old Nellie' and wound up in the driveway of a neat little home set in deep timber.

"Boy," Joe exclaimed as he clambered over the jammed door, "just *look* at all the antennas!"

"Yeah, old FN has quite an 'antenna farm' Joe; he's a nut on separate antennas for every frequency both on his transmitters and receivers and he's got 'em all. He's lucky . . . we don't all have such a lot of space to hang our skywires in."

Ignoring the conventional entrance door, Larry led his protege around to the back of the house and knocked on a basement door on which a set of amateur radio call letters were prominently displayed. "FN is down here in his shack or shop most of the time . . . this is where we'll probably find him" Larry explained.

Sure enough, his knock brought immediate response; "Yeah . . . come on in" and the door swung open.

"Hi, FN" was Larry's greeting to which the old gentleman, removing a battered corn-cob pipe from his lips responded with, "Well, if it isn't LS himself; where you been these past few weeks and, who's your friend?"

"Up to my ears cramming for quarterly

exams, FN; I've brought a new convert to ham radio . . . Joe Blake . . . how's to show him your shack?" "Howdy Joe . . . glad to meet ya; sure, come on in if you can wade through the mess."

Walking to the back of the open basement behind FN, Joe paused in the shop area and said, "Mess? . . . what mess? How can you keep a shop so neat, FN?"

Evidently pleased, their host chuckled and replied, "Wal, let's just say you caught me at a good time; I'm just doing a bit of simple modification to a piece of gear and it don't create much rubbish; you should see this place when I'm working on a really major project. I don't find it hard though to keep 'er in reasonably decent order if I clean up every evening or, if I'm too tired, first thing in the morning . . . it don't pile up that way."

Joe made a mental note of this against the time when he too, would set up shop, and the boys followed FN to a partitioned off corner. Opening a glass-panelled door, their host waved them in saying, "There she be, if you can squeeze in." 'Squeeze' was right; the entire shack was only six feet square and simply *loaded* with gimcracks and gadgets which were completely strange and mystifying to Joe; Larry had made many previous visits to this 'dream shack.' Briefly explaining the general layout FN said, "Four transmitters, four receivers, all on separate antennas and a lot of this and that to control 'em with."

Joe pretty well understood that all of this was electronic gear having to do with advanced amateur radio operation but one item he could not quite reconcile. Above the typewriter shelf against one wall was a conventional Morse telegraph sounder mounted in a wedge-shaped wooden enclosure which in turn was mounted on a swinging metal arm. As it seemed a bit incongruous in a radio shack, Joe was prompted to ask, "What's the telegraph hickey doing here? Looks like those I've seen in railroad ticket offices."

"It is son and it's for the same thing; the Morse telegraph code. You see, I used to be a telegraph operator many years back and there are quite a few of us old Morse men who are also ham operators. When we get together on the air, we like to work the Morse code to just sorta keep our hands in. Morse doesn't sound like it should, when you get it in whistles on a speaker or in a pair of phones so I've rigged me up a little 'converter' deal so that the output of any of my receivers will work the telegraph sounder; much better!"

This brought a further question from Joe; "In the Morse code any different from the radio code . . . I thought they were the same?"

"No lad, there's quite a bit of difference; where the Continental or radio code is all dots and dashes, the Morse code has a number of letters with spaces in them as well. The figures too are all different except the '4,' but you'd better forget about the Morse code until you've licked the radio code first."

This was the opening Larry had been waiting for. "Speaking of codes FN, I've told Joe that's his first chore. So far, he hasn't started his code practice and he can use a few tips from an ol' timer like you. They sure helped me when I first started."

"Well boys," the pioneer ham came back, "I've taught a l-o-t of code to beginning amateurs, Navy and commercial operators in my time and in all these years nothing has been invented to teach the code overnight, in a day or in a week. There just isn't any substitute for practice, practice and *more* practice. Of course there are lots of helpful little hints and tips which will make such learning *easier* and if I can pass on some of them to you Joe, I'll be glad to help you get started. I've got a dental appointment coming up right after lunch today though and I'm not going to feel too chipper this afternoon but tell you what . . . why don't you come back about nine o'clock next Saturday, Joe and you can use my bench and tools and build yourself a little code practice oscillator; you'll need it for your practice. I've got all the parts in my junk-box and it's a simple little building job; give you a change to get your feet wet in 'home-brew' ham construction too."

Oh boy! Did Joe ever jump at *this* chance! Thanking FN profusely and assuring him that his help would really be appreciated, both boys said their 'farewells' . . . Joe even timidly chanced a "73" . . . hopped into ol' Nell and hit the road for home. "Brother, you've struck it rich" said Larry on the way; "FN doesn't take everybody under his wing for in spite of his retirement he seems to be busier than he ever was when he was working and he doesn't waste time with those who show little interest. You went over all right, Joe, and you'll really get a ham education now." Joe beamed all over, leaned back and day-dreamed. Suddenly he said, "Say . . . we forgot to ask him why he picked FN for a sine!"

"By Golly Joe, that's right" Larry replied, "guess you'll have to worm it out of him next week."

Next month: Joe does a bit of home-brewing and gets started on learning the code with helpful tips from FN and a 'surprise' fellow student! . . . W7OE

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How to Re-Fill the Box

Here's a straight-forward linear using 6JB6's.

The December 1963 73 contained a little article I wrote entitled "How to Fill a Box." For some reason or other we got more fan mail on this little jewel than any article I have published yet. This little amplifier worked fine as long as I was on AM or NBFM but I finally broke down and went SSB. As noted in the original article there was no space for a neutralizing capacitor. On 20 meters the amplifier seemed perfectly stable when excited but in the no excitation condition of SSB, when you aren't talking, it showed some erratic tendencies. As a result the "Box" hadn't been used for a couple of years.

Recently I decided to refill the box. What with several commercial outfits coming out with linears using the 6JB6 or 12JB6, I decided to give them a try. The simplicity of the multi-grid grounded grid amplifier has been long known. Such amplifiers using 807's or 1625's appeared in handbooks ten years ago. The -JB6 series however is much more com-

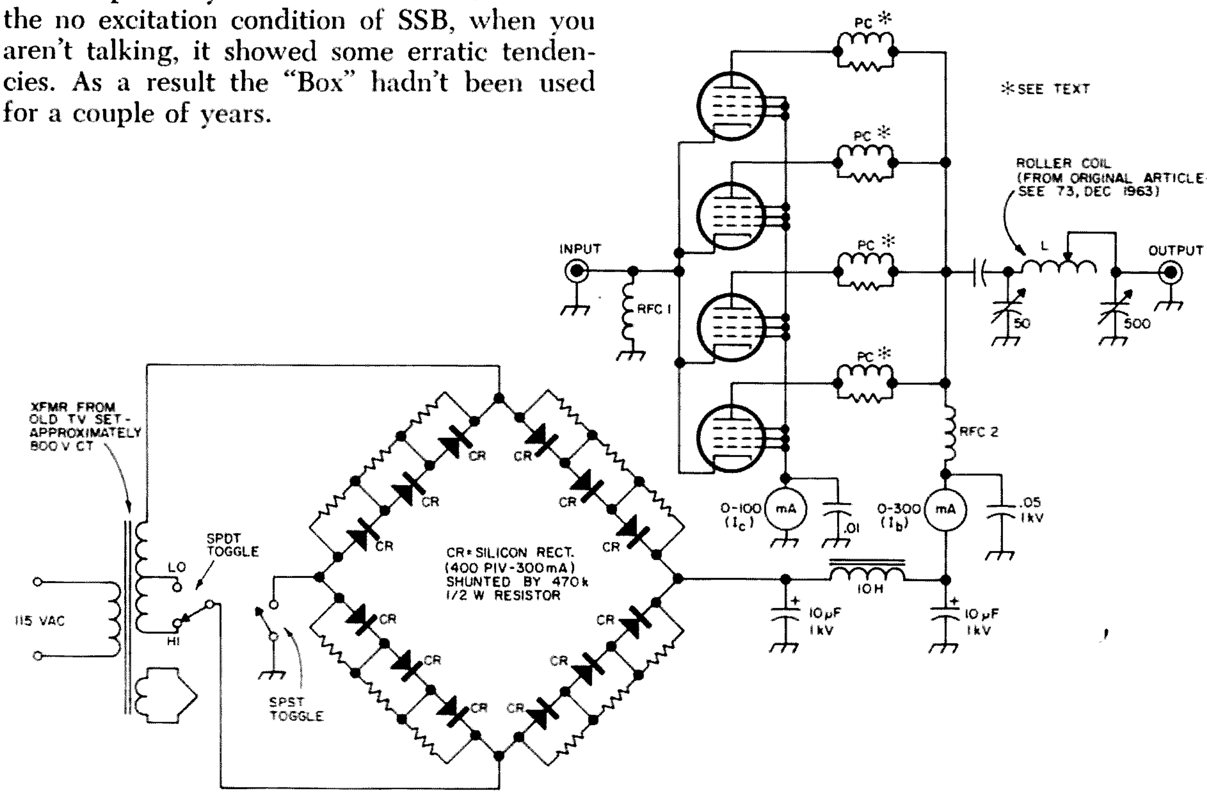
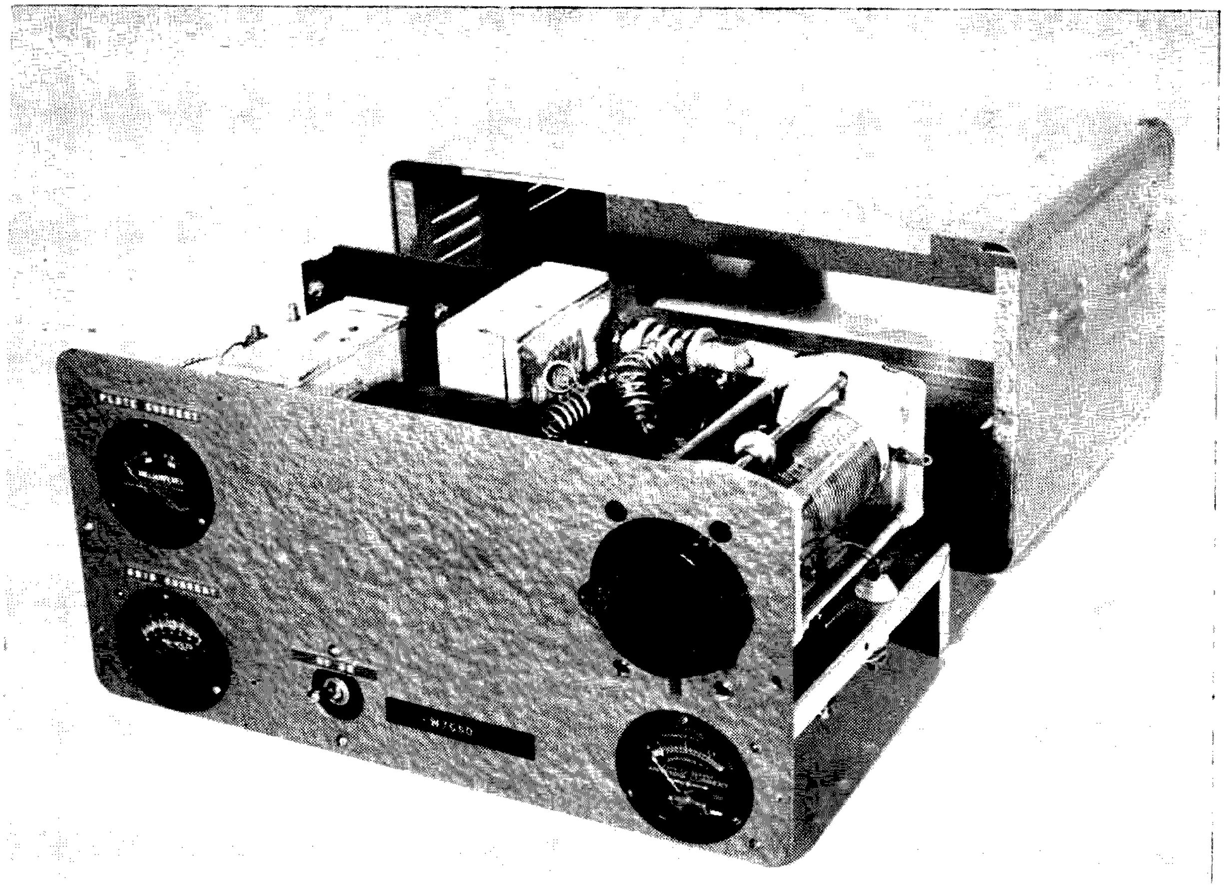


Fig. 1. Schematic of W7CSD's SSB linear using four 6JB6's.



The 6JB6 linear built in the case first used for an 813 amplifier described by W7CSD in the December 1963 73.

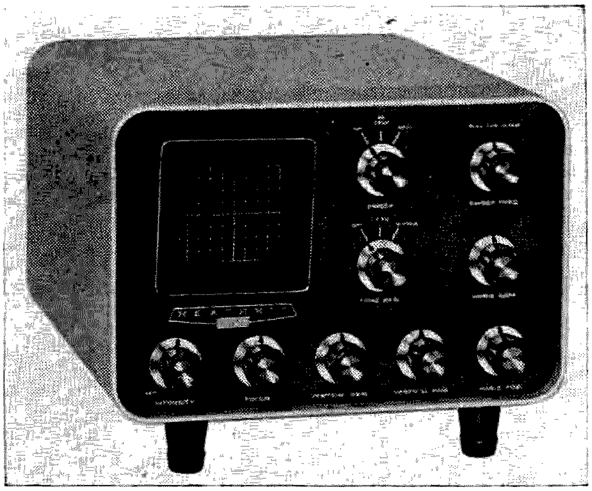
pact and very fortunately fits in the space vacated by the 813. The final result was fewer components and is more stable than the 813 stage. The power out is about the same.

Modifications

There were two major modifications. First the voltage doubler type power supply was changed to a full wave bridge. This required two additional silicon 400 PIV rectifiers with accompanying shunt resistors and a rewiring of the stack. The high-low voltage switch was left in for tune-up procedures. And the filter capacitors were rearranged. Second, of course, the 813 was removed along with its grid circuit. Four novar sockets were mounted for the 6JB6's and all the grids tied together and grounded (through the grid current meter and a by-pass capacitor). Filament voltage was available from the TV power transformer. We put a junk-box RFC in the cathode circuit and tied all of the plates together and fed back to the original pi network. Unfortunately the amplifier took off on a VHF parasitic frequency and we had to install parasitic suppressors in all plate leads. These were made out of 5 turn ½" diameter coils shunted with 100 ohm 1 watt resistors. After this was done very stable and excellent operation was obtained on all bands from 15 to 80 meters. We didn't try 10 as it would be about one turn on the tank coil.

With the TV power transformer the power in is limited to about 200 watts dc. The plate current goes up to between 225 and 250 mA and at this current the voltage is between 850 and 900 volts. One commercial linear using six 6JB6's with 1200 volts claims a gallon PEP —I assume this means 500 watts dc. If one were to go for higher voltage, additional negative bias would be needed on the grids. Resting current of the amplifier as is runs about 90 mA. Possibly the input RFC could be replaced with a cathode resistor of appropriate size. Anyhow once again we wind up with a pretty powerful box full. The measurements of the box (same as before) are 7½" x 8½" x 15". Weight is 25 pounds. Any SSB exciter with a 25 PEP output will drive the linear very nicely.

. . . W7CSD



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Heathkit SB-610 Monitor Scope

Are you interested in what your transmitted signal really sounds like at the other end? Is your new linear amplifier really linear or is it generating a raucous racket that is interfering with other stations on the band? And if it is nonlinear, what is the cause, improper grid bias, incorrect loading, regeneration or parasitics? Well, there is no *one* magic black box that will give you all these answers, but the correct interpretation of the patterns produced by the Heathkit SB-610 Monitor Scope come very close to it.

The SB-610 has proven to be extremely valuable around my shack and its versatility appears to be limited only by the ingenuity of the user. The engineers at Heath planned way ahead when they had this little jewel on the drawing board. Besides monitoring the behavior of your favorite linear, it will give you some insight to almost any type of transmitted signal, be it AM, CW, RTTY, or SSB. You can also check the other fellow's signal by connecting the Monitor Scope to your station receiver. Additional parts are included in the kit so that the vertical amplifier section of the scope may be tailor made to fit your own particular requirements.

SB-610 Specifications

Vertical Amplifier
Input resistance: 100 kilohms
Sensitivity (for 1 inch deflection):
Untuned: RTTY, 1 volt nominal
20 kHz–455 kHz, less than 500 mv
Tuned: 455 kHz, 70 mv nominal
1600-2500 kHz, less than 200 mv
3000-3400 khz, less than 500 mv
5000-6000 kHz, less than 700 mv

Horizontal Amplifier
Input resistance: 1 megohm
Sensitivity (for 1 inch deflection): 800 mv
Frequency response: ± 3 dB from 3 Hz to 15 kHz
Tone Oscillators
Frequencies: Approximately 1500 and 1950 Hz
Output voltage: 50 mv

Miscellaneous
Frequency coverages: 1.8 MHz through 54 MHz, 50-75 ohm coaxial input
Signal power limits: 15 watts to 1 kilowatt
Power requirements: 120 Vac 50/60 Hz, 35 watts
Dimensions: 6 H x 10 W x 11⅛ D.
Price: $69.95

For monitoring RTTY signals and with receiver *if*s up to 150 kHz, the vertical amplifier is an untuned arrangement with a resistor as the plate load. For *if*s of 455 kHz and above, the necessary *if* transformers and tuning capacitors are included in the kit. By changing these components, the Monitor Scope may be used with just about any *if* from 455 kHz up to 6 MHz.

In addition to monitoring duties, when the vertical amplifier is wired for use to 150 kHz, the Monitor Scope may be used as a conventional oscilloscope. Its vertical sensitivity is somewhat limited in this applicaton, but for many purposes it is perfectly suitable. Here again the design engineers have come through with flying colors, providing much of the circuitry found in many bench-type oscilloscopes, including adjustable sweep and synchronization.

The Monitor Scope is easy to build and a snap to use. With the excellent guidance pro-

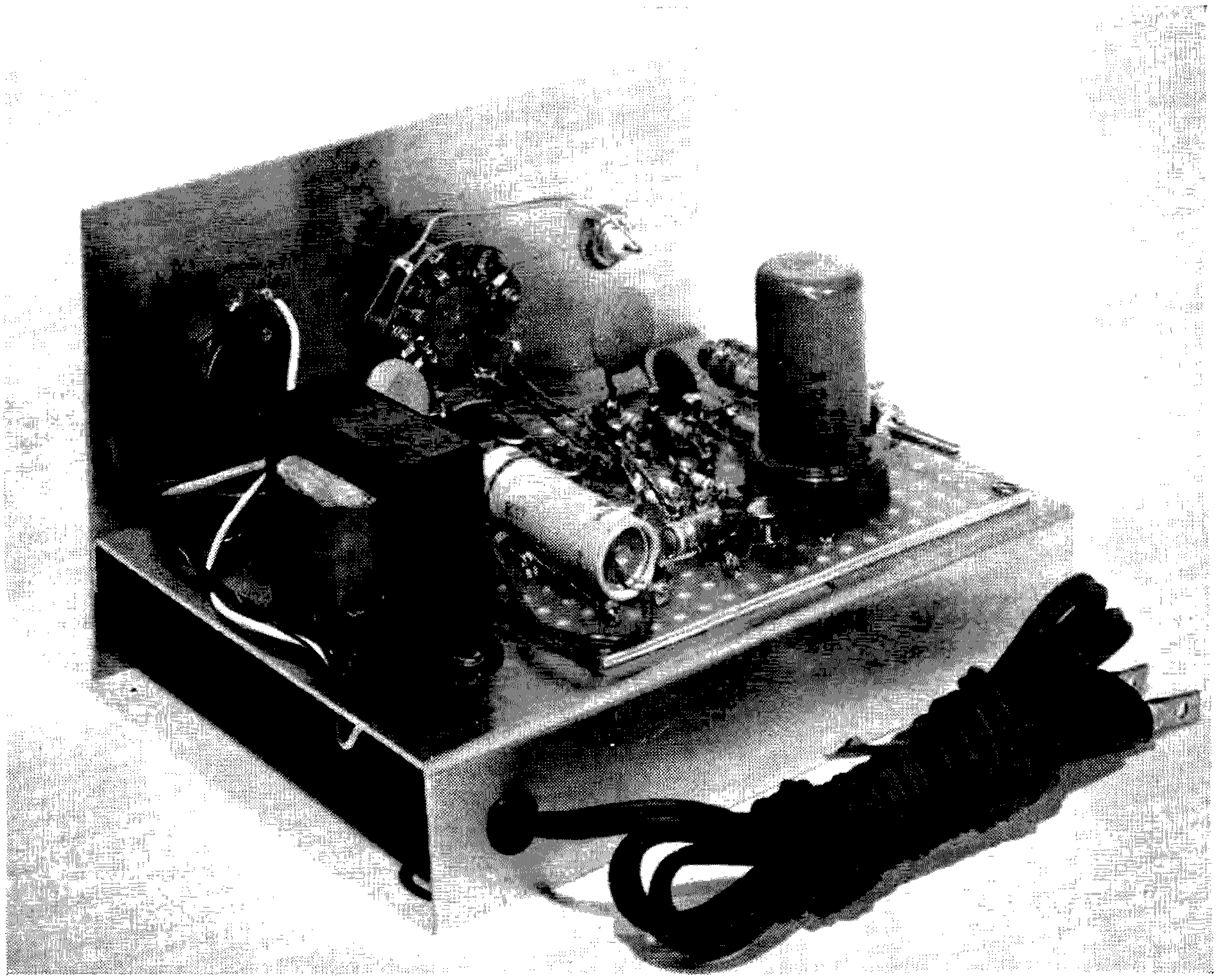
vided in the instruction manual, even the inveterate novice can make some pretty sound deductions about signal quality. The manual is liberally illustrated with typical scope patterns; each is discussed in detail and if it is indicative of poor signal quality, some of the probable causes are listed. For monitoring with the station receiver, a series of patterns in the manual show the effect of receiver bandpass and avc action on the received signal. These should be considered when making on the air checks.

Although designed for use on the ham frequencies from 1.8 MHz to 54 MHz, excellent results may be obtained up to 100 MHz. The Monitor Scope can be used on two meters, but there may be some distortion of the pattern. The unit will safely take a full kilowatt and will operate properly down to about 15 watts. A step attenuator on the rear panel provides up to 24 dB attenuation when adjusting the scope with a particular transmitter or linear amplifier.

For testing single sideband transmitters, a two tone test generator is built in. The frequencies of this generator, approximately 1500 kHz and 1950 kHz, have been chosen so that their second harmonics fall outside the normal audio passband of modern ssb transmitters. It is the attention to small details such as these that really make the difference when making qualitative measurements.

One of the problems with many monitoring scopes is that during receive periods the scope trace remains stationary in the center of the CRT. If the trace is not turned off to one side of the face of the CRT it will eventually burn a hole in the phosphorus. In the Monitor Scope however, the Heath engineers have come up with a neat solution to this problem. In their circuit a *clamp* tube is used to move the trace over to one side of the CRT. This clamp tube may be controlled manually, or automatically when the scope is operated in either the RTTY or RF Trapezoid mode. In the automatic position, a sample of the transmitter rf power is rectified and used to turn the clamp tube off, thereby restoring the trace to the center of the CRT. Usually about 100 watts is necessary to provide enough rf for this purpose; for lower input power levels it is necessary to use the manual mode.

For monitoring or checking any type of amateur transmitter, it is hard to beat the SB-610 in performance and cost. Whether it is used at the bench in testing equipment or in your shack for on the air checks, you will find it to be a very useful and worthwhile addition to your station. . . . W1DTY



Back view of the Mark II crystal calibrator. It puts out markers every 25, 50 and 100 kHz.

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The Mark II Calibrator

Use readily-available integrated circuits in this useful marker generator. It puts out strong signals every 25, 50 and 100 kHz up to the six meter band.

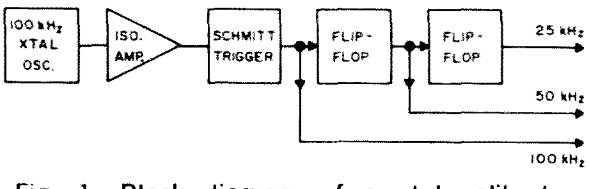


Fig. 1. Block diagram of crystal calibrator with integrated circuit frequency dividers. W6GXN calls it the Mark II—the Mark I was described in the August 73.

In the August '66 issue of 73, a crystal calibrator was presented which utilized a flip-flop to provide 50 kHz interval frequency marks.[1] The reasons for using digital circuits for the frequency division were developed in that article. It was also pointed out that a second flip-flop could be added, if one were to desire 25 kHz interval markers.

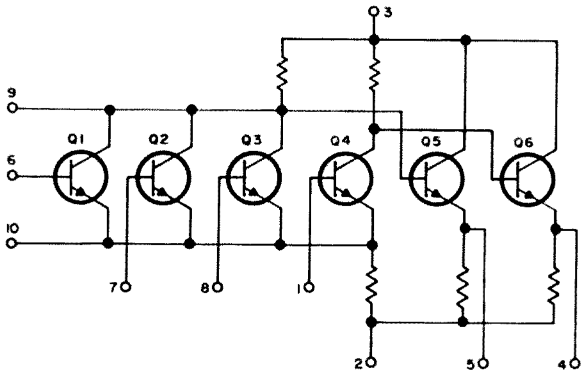


Fig. 2. Circuit diagram of the HEP 556 "three input gate."

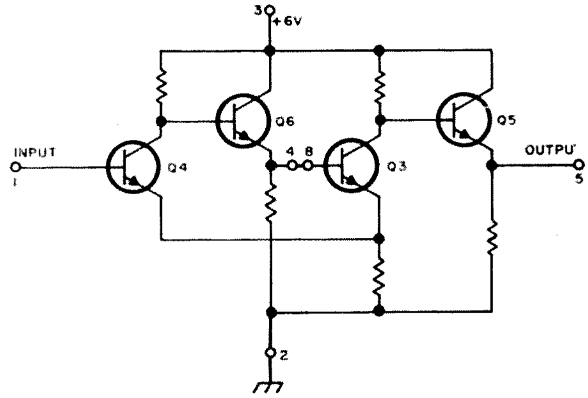


Fig. 3. Three input gate as modified to form a Schmitt trigger.

In the Mk II, herein described, use is made of the relatively new integrated circuits (IC's) for the digital circuits. IC's allow for a great simplification in the calibrator construction; in fact, the Mk II circuit board, with two flip-flop is significantly smaller than the original calibrator board with only one flip-flop.

1966 has seen the IC field literally *explode*, as described in a recent issue of Time Magazine.[2] The prices during this period have finally fallen to levels at which amateur radio experimenters can get interested in IC's. Also, the Motorola Company—the first to do so, to this author's knowledge—has added a number of digital IC's to their HEP (Hobby Experimenter Products) line. This means that, now, at least several IC types are available, at reasonable cost, nearly *anywhere* in the USA.

It is around the Motorola HEP line of semiconductors that the Mk II calibrator is designed. The basic block diagram of the Mk II is shown in **Fig. 1.** It consists of a crystal oscillator, an isolation amplifier, a Schmitt Trigger, and two flip-flops. The Schmitt Trigger is a HEP 556 "Three Input Gate" and the flip-flops are both HEP558 J-K types. The crystal oscillator is a standard Colpitts type with the crystal in the series-mode. This particular crystal was removed from a surplus ARC-2 aircraft transmitter, and was apparently cut for series-mode operation. The isolation amplifier is of ordinary design.

The problem of which digital IC to use as a Schmitt Trigger was rather interesting, since none of the HEP line was specified for that application. The circuit of the HEP 556 is shown in **Fig. 2** since it is the unit decided upon for the trigger. The individual transistors have been labeled Q_1 through Q_6 for discussion. Q_3 and Q_4 are to be the basic two transistors of the Schmitt Trigger, since they both have collector load resistors and have a common emitter resistance. Cross coupling from the collector of Q_4 to the base of Q_3 is through the emitter-follower Q_6. The "Three Input Gate" as wired for trigger service is then as in **Fig. 3.** One will note that transistors Q_1 and Q_2 were "wasted" and that the output is obtained through the second emitter-follower Q_5.

The J-K Flip-Flop, as represented by the HEP 558, is a far more complicated device than the simple flip-flop ordinarily encountered by the ham. The fact that the J-K contains some 16 individual transistors is an indication of the complexity. The J-K is a very versatile unit in the digital service for which it is intended, which justifies its complexity. We are to use each J-K simply as a divide-by-two stage. A group of these same J-K's can be connected so as to divide by many other whole numbers (not to exceed 2 per J-K) including the very useful number: 10. Dividing by prime numbers like 5 can be done with such an array of J-K's *without* critical feedback networks of capacitors and resistors; only the method of inter-connecting wires must be

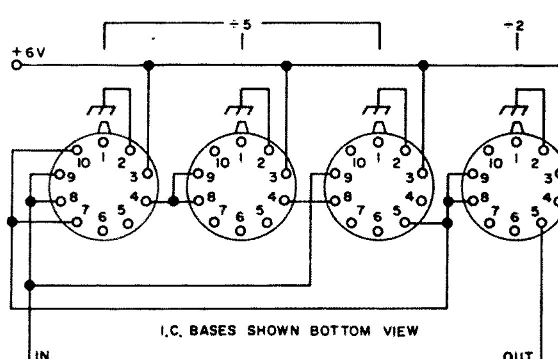
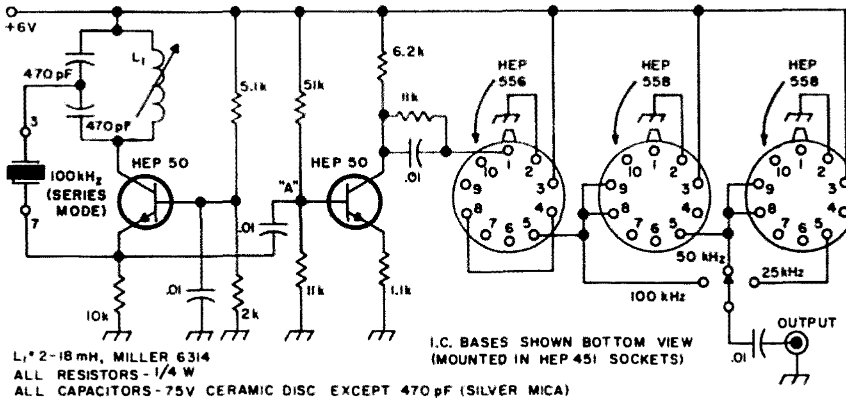


Fig. 4. Decade divider of four HEP 558's.

Fig. 5A. Mark II Calibrator. Power supply section of the calibrator is shown in Fig. 5B.



changed. Dividing by 5 takes three J-K's, dividing by 10 takes four J-K's, and so on.[3] The method of connecting HEP 558's for division by 10 is shown in **Fig. 4.** Note that this is accomplished by first dividing by 5 and then dividing by 2. More information on the HEP 558 and other IC's in the HEP line is contained in the Integrated Circuits Project Manual.[4]

Putting all the building blocks together into a unit, we have the Mk II Crystal Calibrator. The circuit is shown in **Fig. 5.** The circuit was constructed on Vector board, which in turn was mounted in a square hole on a metal chassis. Power transformer, fuse, switches, and output jack were mounted on the metal chassis and panel.

In operation, the calibrator produces good mark intervals up to the six meter band, which should be adequate for most ham purposes. The calibrator, of course, is coupled to the receiver antenna input via a 5-pF capacitor or a capacitive "wire-gimmick". One interesting phenomenon is noticed, when using the Mk II calibrator on 50 kHz or 25 kHz. The "even" harmonics of either of these frequencies are much weaker than the "odd" harmonics. This should come as no surprise, since the Fourier analysis of a perfect square wave contains *only* odd harmonics in theory. In other words, the J-K Flip-Flops produce such symmetrical square waves that the Fourier analysis theory is approximated. The output of the Schmitt Trigger is not so nearly symmetrical, and all the harmonics of 100 kHz are quite evident. The fact that the "even" 50 kHz marks may not be easily heard is no problem, since *these "even"* marks are given to us by the 100 kHz position. And similarly the "even" 25 kHz marks are given to us by the 50 kHz and 100 kHz marks.

If one is going to use a 100 kHz crystal of the commonly available type like the CR37/U, an FET crystal oscillator circuit may be substituted for the crystal oscillator circuit. One for use with a crystal that is resonant at 100 kHz with 20 pF in parallel is shown in **Fig. 6.** The whole subject of which crystal to use with which oscillator circuit is covered in reference number 4.

. . . W6GXN

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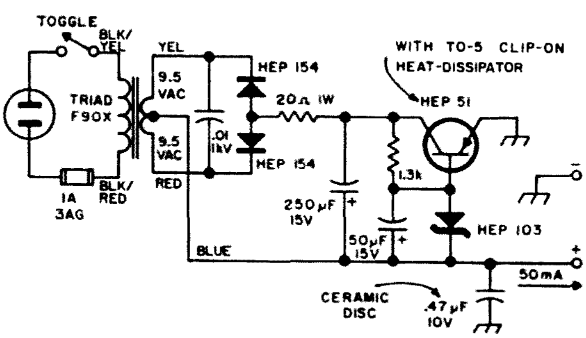

Fig. 5B. Regulated power supply for the Mark II calibrator. Output is 6 volts.

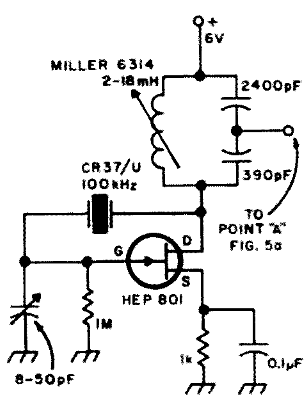

Fig. 6. Alternate crystal oscillator for use with 100 kHz crystal designed for 20-pF parallel resonance.

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LORAN

Interloper on 160

Most amateurs and SWL's are well-familiar with the strange, rasping static-like signals which all but crowd out the once-proud 160-meter band. And crowd out 160 they have, so that at present relatively few countries allow any operation at all on 160 and those that do severely restrict the type of emission, frequency band and power limits. A complex system authorizes limited top-band operation in the U.S., with some areas near coastlines allowed only 25 kHz and other areas nighttime powers as low as 25 watts.

LORAN, which is military jargon for "LOng RAnge Navigation," is the villain responsible for that empty notch on the bandswitch where 160 used to be. But what is it, and why is it so important?

This system—developed semi-secretly by the British during World War II but expanded considerably after the War—is a complex one which provides the ship or aircraft navigator with "lines of position" on which he can know his craft lies. Before its development, traveling over water for long distances, the navigator had few methods for accurately determining his position and was generally limited to celestial observations and radio direction-finding sets.

The LORAN receiver electronically "reads" the difference in arrival times of signals from two known ground transmitting sites, a "master" station and its "slave." The two signals are presented on a CRT—the whole receiver resembling a cross between an oscilloscope and a radar set.

Since radio energy travels at a constant speed and the transmitters' locations are known, the exact arrival-time differences between master and slave can be calculated and printed on a map-like chart in hyperbolic curves around the stations. The time-differences read-out from the receiver counter dials indicate the hyperbola or line of position on which the aircraft or ship is located.

Despite the very long range of LORAN, up to about 900 miles during daylight and 2000 miles after dusk, amazingly accurate results are possible. Operating on four channels, 1750, 1850, 1900 and 1950 kHz, an accuracy of ⅛ mile on groundwave and a few miles on E or F-layer skip is not extraordinary.

The big "hitch" comes in from the effects of sky waves. Waves reflected off the ionosphere take longer to travel the same ground distance and would cause tremendous errors if they were not identified as skywaves rather than groundwaves and the proper corrections applied. Fading and wave-cancellation has a

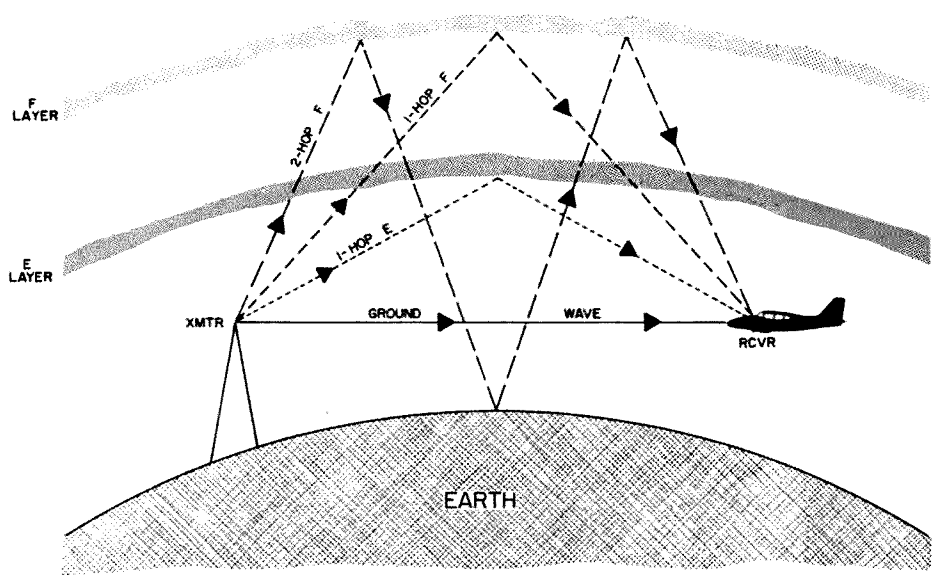

Fig. 1. This diagram shows the various paths which the Loran signal, like any other medium frequency transmission, can take. Since a longer effective distance exists between the transmitting station and the receiver with sky waves, it will take longer for them to travel the same ground distance. This must be accounted for or large errors would result.

similar effect on LORAN as it does an RTTY —reception is garbled and erroneous.

Once the navigator has identified whether he is receiving groundwave, or single or multiple-hop E or F skip, he can perform a few quick calculations and establish his line of position, then crossing this with another line of position (LOP)—such as from another LORAN station or a celestial body—to get an actual position or "fix."

LORAN stations are usually constructed to dot one end of an important coastline to the other, such as our East and West Coasts, which accounts for the limited amateur operation on the Coasts. To ensure adequate coverage, pairs of master and slave stations are strung out in-line to form an unbroken station chain along the coastline. Interestingly, the stations may even operate on the same frequency channel without interfering with one another since each has its own characteristic pulse rate.

Unfortunately, LORAN is susceptible to atmospheric interference and, more seriously, to co-channel interference (i.e., we hams) and to enemy jamming and deception in which the enemy sets up his own false stations to 'con' the navigator into thinking he is where he isn't. To counter this sort of thing, it is possible to set into the stations an "extra" time delay so that the values printed on the navigator's chart do not jibe with what his set reads. Only those knowing the code-of-the-day could use the signals and would not be deceived.

What is the future of LORAN and how will

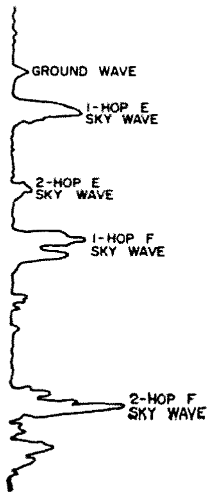

Fig. 2. Typical train of Loran pulses as they might appear during night-time hours on the navigator's set. The ground wave, if close enough to the station, always is seen first with the various sky waves following.

it affect amateur 160-meter work? Newer VHF and UHF navigation systems, such as TACAN, VOR and even navigation satellites, will slowly spell the doom of LORAN. Also, experiments have begun to transfer LORAN to the 100 kHz area (which is considered a more "reliable" operating frequency than 160), but it will doubtless be a number of years before all trans-oceanic aircraft and seagoing vessels convert over to the newer system, and the present 160-meter LORAN would probably remain in operation as a back-up, amateurs sharing it still on a non-interference basis.

This, then, is LORAN, interloper on 160, but to the navigator some two thousand miles from familiar shores, his best friend.

. . . K2IKZ

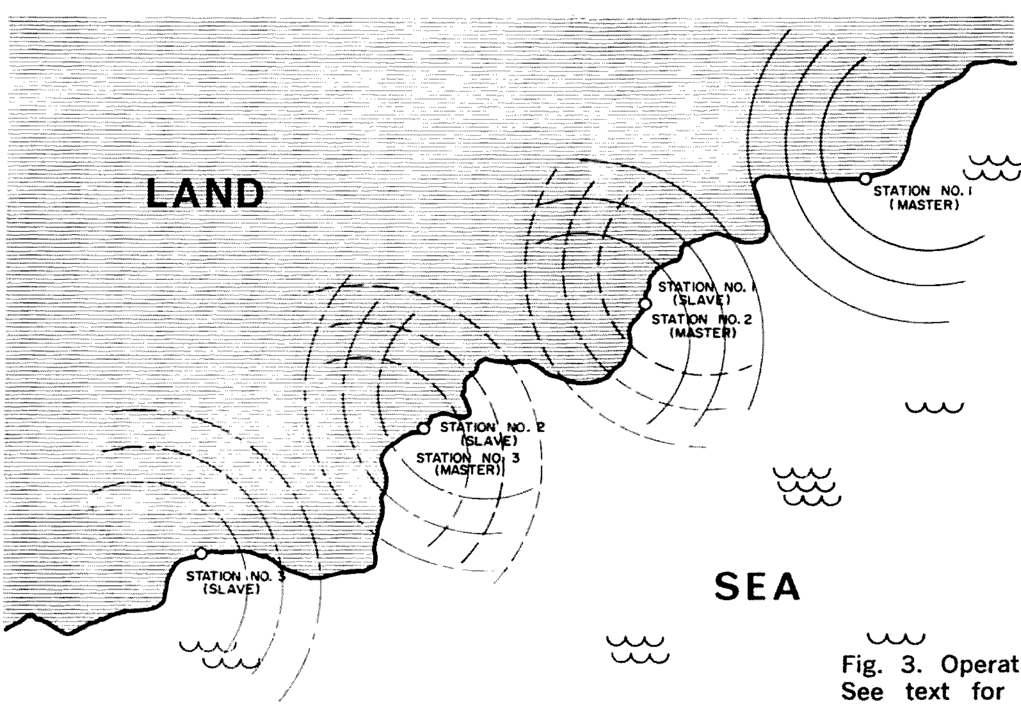

Fig. 3. Operation of LORAN. See text for explanation of the system.

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PAK—The Portable Automatic Keyer

A keyer to be useful for portable operation must be designed so that its power drain is low. This will allow its battery to be conveniently small, but still have long life. The PAK (Portable Automatic Keyer) excells in this area. The grid block keying model has the key up current drain of 0.2 mA and the key down drain of 3.6 mA. The cathode keying model also has the key up current drain of 0.2 mA, but the key down current is necessarily higher —10 mA. The PAK is a relayless keyer but special care was taken to be sure cathode keying DX-40 owners and 6146 homebrewers can update their rigs with an automatic keyer. It has sufficient flexibility designed into it so the builder will be able to make good use of his junk box, also, the parts are few and all can be economically purchased if desired.

The PAK, instead of containing a relay to switch the transmitter keying circuit, uses very low cost transistors in series (grid block keying) or parallel (cathode keying). By this method the cranky relay problem is eliminated and, at the same time, we gain almost unlimited substitution possibilities. The series circuit raises the keying voltage capabilities to a useful value and increases the key open resistance to a fantastically large figure. The parallel circuit increases the current handling capabilities and the key up resistance remains high enough for most grid block keying circuits. Both models are self completing and are identical except for the high voltage switch. The cathore keying model will be treated as a modification to the grid block model, because it requires fewer parts and is a bit less complicated.

When the PAK is constructed with the grid block keying switch it presents a key up resistance so great that no current flow can be detected on a 50 microamp meter when 250 Vdc is impressed across its terminals. Its key down resistance is very low, about 53 ohms. When using Poly Paks equivalent 2N498's currents of up to 30 mA can be switched. This all boils down to: the PAK can easily short the 250 Vdc to ground through a 25-KΩ resistor and there will only be about a half a volt left over across its terminals. The resistor can even be reduced to 10-KΩ with perfectly safe operation. When using 2N333's the voltage handling capabilities of the unit is reduced to 125 Vdc and the current to 25 mA. This means that the 25-KΩ and 10-KΩ resistor still can be shorted out with the same safety as long as the blocking voltage does not exceed 125 Vdc. The Pak's low voltage drops along with its capability to switch to high voltages make it ideal for grid block keying a couple of 6146's plus a VFO, using the 2N333 transistor switch. If your rig uses a higher blocking voltage for larger tubes, the equivalent 2N498's will do the job for you. You can determine the value of your blocking voltage by measuring across your key with a VTVM when the key is open. The maximum value of the voltage in a cathode keying system can be measured in the same manner. The current can be measured by connecting a milliammeter across the open key. This will cause the transmitter to go on so be sure that it is loaded at the output.

When the PAK is constructed with the cathode keying switch its key resistance depends upon the quality of the transistors. With half good transistors its key up resistance will be great enough not to effect the keying of the low impedance cathode circuit. The key down resistance will be about 10 ohms. With the 2N498's key up voltages can be up to 100 Vdc, but with the equivalent transistors this figure must be derated to about 75 Vdc, a value com-

patible with DX-40. Either of the two kinds will handle key down currents of up to 150 mA.

The timing section of the PAK consists of normally off or on switch circuits using transistors also available from Poly Paks. This design permits reliable operation in the presence of large rf signals, very low battery drain and an easy-to-understand easy-to-maintain circuit. It is a simple solution to the not-too-difficult problem of making dots and dashes, and it is hard to see where complicating the solution with blocking oscillators, count down flip-flops and several types of gates is necessary. The PAK also has a fine range of speeds, and when the components shown in **Fig. 1** and **Fig. 2** are used, it will operate from about 10 to 25 wpm.

An examination of the schematic (**Fig. 1** and **Fig. 2**) reveals that the PAK circuit is built around six transistors. Q1, Q2, and Q3 compose the high voltage switch. Three transistors are used in series (**Fig. 1**) to permit reliable operation with potentials across the output terminals up to 250 Vdc, or three are connected in parallel (**Fig. 2**) to assure reliable operation with keyed circuit currents up to 150 mA. The timing circuit is alike for both the grid block and cathode keying models. Q4 and Q5 are normally off switches while Q6 is normally on. When the key is closed, C1 or C2 will discharge through Q6 biasing Q5 on, which in turn, drives Q4 and Q1 through Q3 on. The positive signal from the on Q4 is fed back through C3 to decrease the circuit rise and fall time and back to Q6 biasing it off. This event disables the key lever and allows the timing capacitors C1 or C2 to charge through the Speed Control R6 and determine the period that the high voltage switch will be on. Thus, the circuit now acting independent of the key lever, is self completing. The Speed Control not only regulates the duration of the on time, but also controls the effectiveness of the space capacitor C4 which must discharge before the key lever again becomes active. By making dual use of R6 the ratio of space to chactor is very linear over a wide range of speeds.

The PAK is made of easily obtained low cost materials but no compromise is made with reliability. A quick glance at the unit might mislead one into thinking construction is a complicated job, however, no special tools or skills are required. The key and electronic components are mounted upon a piece of Vector brand breadboard 3″ x 3¹³⁄₁₆″ (the full board width). The key is a bent-up assembly made from aluminum cut out of a .025″ thick cookie sheet, with the contact insulators and handle made from small pieces of Vector board. The contacts are bolts which have had their ends cut very smooth, and the knob is whittled out of soft wood, then painted. Construct the base by melting two pounds of fishing sinkers in a can and pouring the molten lead into a mold the size of the circuit board. After it has cooled cement an insulating card to the top and rubber pads to the bottom. Mount the circuit board to the base using spacers to prevent crushing the components. A battery case is made out of cardboard ce-

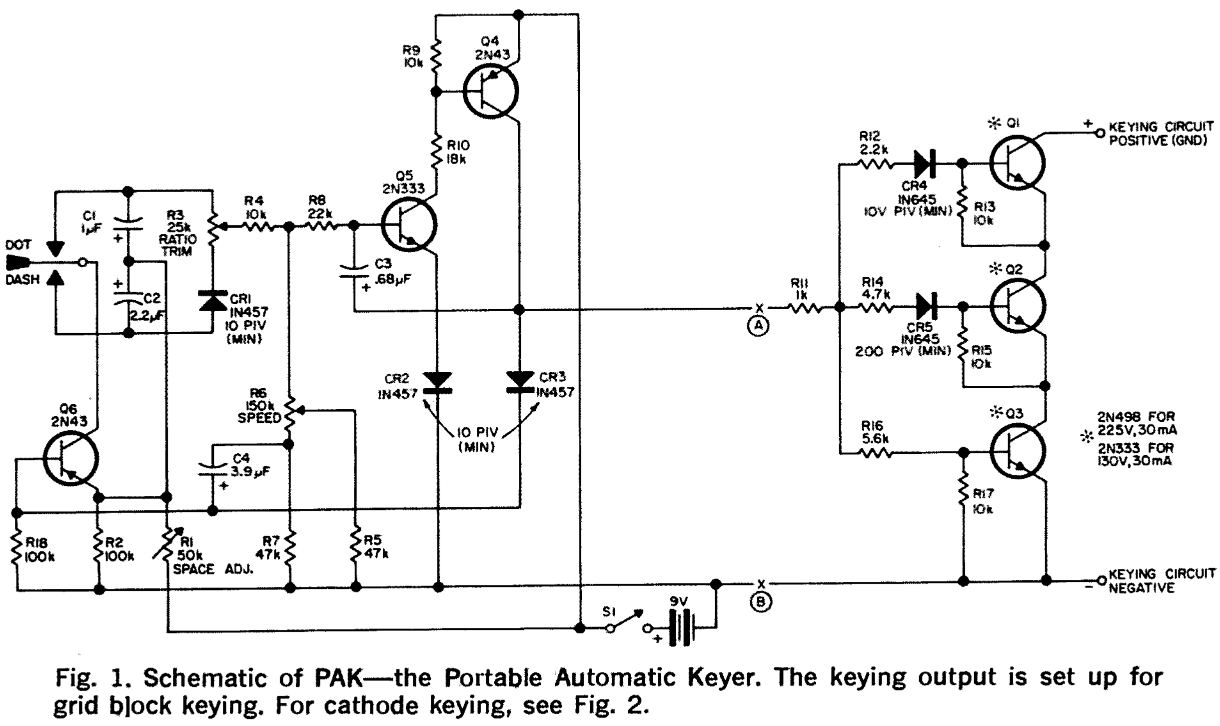
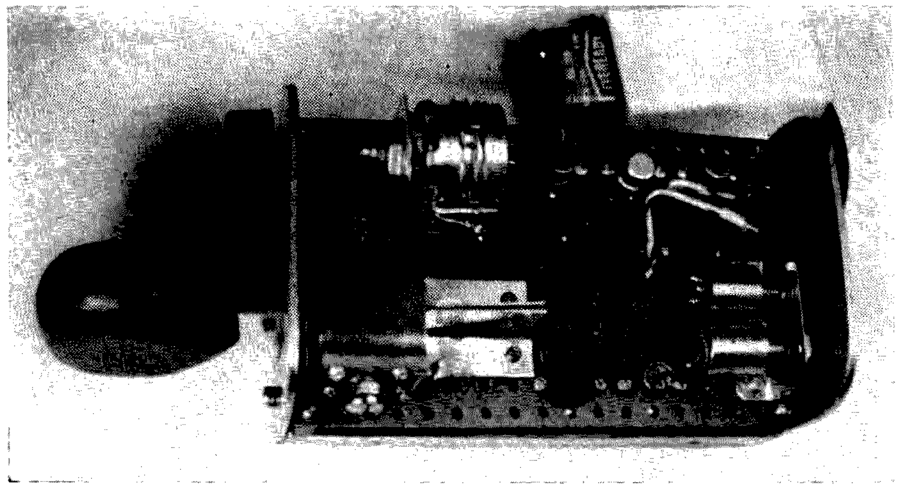


Fig. 1. Schematic of PAK—the Portable Automatic Keyer. The keying output is set up for grid block keying. For cathode keying, see Fig. 2.



Inside PAK's case.

mented in the corners to form something like a little box. The plug can be the top off a dead transistor battery. The front and rear panels along with the cover are held in place with screws that fit into holes tapped in the base edges. Cementing your call and QTH, which can be cut out of your QSL card, to the top cover gives the keyer a real custom appearance, especially if the color of the knob and letters match.

Adjustment

Adjustment of the PAK's trim controls is identical for the grid block and cathode keying models. If an oscilloscope is available, set the scope "Y" input to the dc mode and connect it to the Q1 side of R11. Connect the scope ground to the 9 V battery negative line. Adjust all keyer controls to midposition. Turn SI on and hold the key to the dot position. Watching the scope adjust R1 for a square wave presentation. Alternately place the key lever to

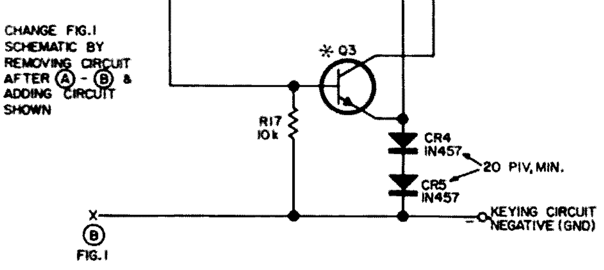


Fig. 2. Adapter for cathode keying. Replace the portion of Fig. 1 right of A-B with this circuit.

the dash and then the dot side while watching the scope and adjusting R3 until the ratio of the dashes to the dots is about three to one. Readjust the space control, R1, for a square wave, and check the keyers performance throughout the range of the speed control, R6.

Without an oscilloscope all is not lost. You can use the audible signal produced by an audio oscillator, or one produced by your VFO or dummy loaded transmitter in a receiver. After all, the final test of any keyer is whether it sounds right. Because the PAK uses transistors in the output switch, it will be necessary to connect a diode in series with one lead of the audio oscillator. Connect the diode so that its cathode is fastened to the keyer positive output and its anode to the oscillator. The other lead from the oscillator will have a speaker or earphone in series with it and be connected to the keyer negative output. When using an audible signal, adjust the trim controls in the same sequence as when using the scope.

The connection of the PAK to your transmitter requires a little attention. Considering first connecting to a grid block keying system. In this case you will have to connect the keyer positive output terminal (Q1 collector) to ground, and the negative output terminal (Q3 emitter) to the keying line. Connection into a cathode keying system will require that the keyer positive output terminal (Q1 collector) be fastened to the keying line and the ground to the keyer battery negative buss. In both cases the base, the cover, and the panels (chassis assembly) must be connected to ground for safety and shielding.

You will find that the PAK will give you many hours of outstanding service with only one battery and its fine operation plus its custom appearance will be admired by every one who gets the opportunity to use it.

. . . K3QKO

Jim Kirk, W6DEG
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San Francisco, Cal.

Make the Most of Magazines

And have fun doing it.

If you throw your magazines in a pile, and then search for a back reference, only to find you have given it to a "bookkeeper," you are not getting your money's worth from magazine subscriptions. Definition of a "bookkeeper"—One who borrows a book and *keeps* it.

There is so much pleasure to be derived from magazines by keeping them in a handy file, and then having the year's issues bound in a book. Of course 73, and some other magazines, sell binders, and you can pay to have them bound in a book, but all that costs money. Not only do you save money by doing it yourself, but a great deal of satisfaction and fun results.

To start on the right path, and have fun doing it, as soon as you get the February issue of any magazine, measure one inch and a half from the top and the bottom—punch holes with an ice pick, starting a file as in **Fig. 1.**

Jim is 71. He's been a ham continuously since the wireless days of 1908. He was a pioneer broadcaster in the West with KFFR and still likes to build. Almost all of his ham equipment is home made, as are his desk, benches, files, color TV and electronic organ!

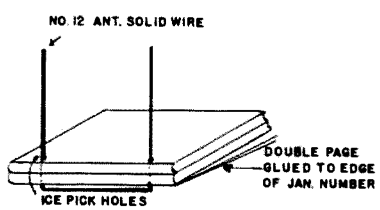

Fig. 1. Temporary magazine file.

When you receive the December issue, you have material for a book, complete with index. You can be your own bookbinder, and turn out neat volumes, improving with practice. A tip here, take an old book apart to see how it is made.

To make a book from magazines, first remove the wires you used for a temporary file, then remove the staples. A magazine such as 73 is a cinch to bind, because it consists of only one folio, stapled in the middle. Magazines put together as QST are, are more difficult, because they consist of a bunch of folios, stapled on the ends and glued together. They are not impossible, though. You remove the staples, and then separate the folios. The front cover and back of QST are one piece. I cement the cover to the first folio and throw the back away. It only contains an ad. (Forgive me, RCA).

The next step is the construction, and use, of a sewing frame (See **Fig. 2**). Glue a folded piece of heavy wrapping paper (you can get it free) to the front of the January issue and

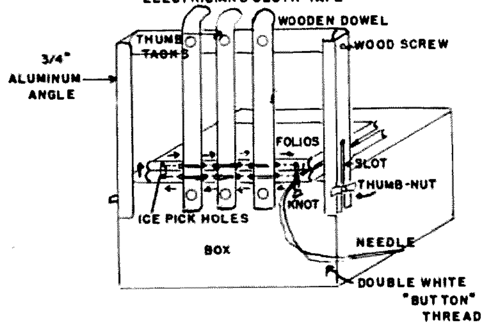

Fig. 2. Sewing frame for books.

to the back of the December issue. If you want to be fancy, an art store will sell you pretty designed paper for this purpose, although the main idea is to *buy* as little as possible. Let your motto be—Use materials at hand.

Place the first folio on the box under the frame, and punch holes in the folio with an ice pick. Sewing it with white "button" thread is easy. After you have sewed a year's issues together, place the "book" in a home made clamp, and glue the ends together, placing a bit of cloth or heavy paper to make it more solid. The glue can be glue flakes sold by hardware and art stores. You dissolve it in water and heat it on the kitchen range. (When the XYL is out) See **Fig. 3.**

Buy an inexpensive piece of ⅛" cardboard (called "chipboard" in art stores). Buy black upholsterer's leatherette at a supply house. Use the thin cardboard the laundry puts in shirts for the center. (See **Fig. 4.** Take your book from the clamp, when the glue is set, and place it on the covers and glue the front and back. The book can then be pressed under some heavy surplus equipment.

When the book is done, an added refinement would be to draw the name of the book and the year, and have a glossy negative photostat made. Cement ths label on the back, making your book easy to identify. A further refinement that is extremely helpful, is to go through your book, marking articles of exceptional interest (such as this one!) with a little cardboard tab cemented to the page. This will be helpful in reviewing subjects.

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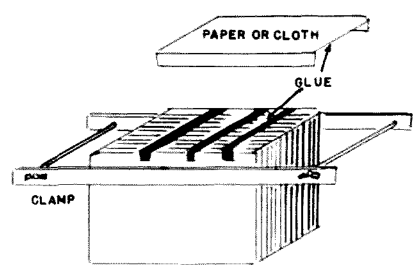

Fig. 3. Forming the book.

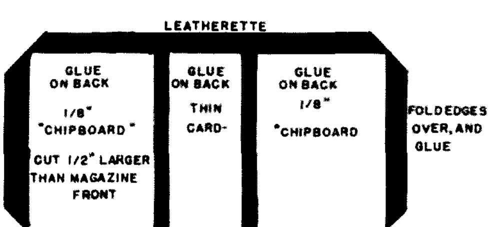

Fig. 4. Back of the book.

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John Schultz W1DCG/W2EEY
40 Rossie Street
Mystic, Ct. 06355

A Coax Coaxial Antenna

Here are two extremely simple and inexpensive methods for constructing a coaxial antenna, which may be used for home station or field-day use.

The use of coaxial antennas has usually, except for some 10 meter commercial versions, been restricted to the VHF range because of constructional difficulties. The antenna has the same low-angle radiation characteristics and lack of feederline radiation qualities as a ground plane but is less conspicuous in appearance because of the lack of radials.

The usual base-supported coaxial antenna, made from tubing, is shown in **Fig. 1**. However, a number of "field-day" type coaxial antennas can be made using only coaxial cable. Such construction is as inexpensive as possible and allows easy suspension of the antenna from a tree or other support.

One of the earliest types of field-day coaxial antennas was a form used by the Army and called a "limp" antenna **(Fig. 2)**. The coil on the bottom of the antenna was resonated to the antenna frequency and served to decouple the shield of the coax above it, thus allowing the shield to act as the skirt of a coaxial antenna. The coil was resonated either using a calculated chart or with the aid of a grid-dip meter. The difficulty of constructing a support for the coil plus the fact that the resonance of the decoupling coil was fairly sharp detracted somewhat from the usefulness of the antenna as a military field expedient. Dimensions are given for coils for 10 and 15 meters. By the way, if anyone knows the derivation of the term "limp" antenna, I would appreciate hearing about it.

Another expedient method of coaxial antenna construction I heard about was to remove the jacket from a length of coax, loosen the shield, and then push the shield over the jacket on the remaining length of cable—thus using the shield to form a skirt **(Fig. 3)**. The idea sounds extremely simple but when I tried it, I found it to work only with the larger cables (RG-8) and then only with a great deal of effort.

In the frustrating process of trying the above method, I developed another extremely simple method of forming the skirt. Basically, the shield is slipped off from a larger size coax (RG-8) and then the shield is slipped over the jacket of a smaller size coax (RG-58 or RG-59) and used as the skirt of a coaxial antenna. The shield, when it is placed over the RG-58 or RG-59 should be stretched smooth so it will "hug" the cable jacket. This process will elongate the shield somewhat and it should be remeasured and trimmed as necessary and then taped every few feet to prevent it from changing dimension.

For a quick "field-day" setup, the jacket and shield can be removed from a piece of RG-58 to the required radiator length and the skirt (RG-8 shield) soldered directly to the RG-58 shield. However, flexing will, over a period of time, tend to break the relatively small solid conductor of the RG-58 inside the dielectric where the skirt and shield join. Therefore, for

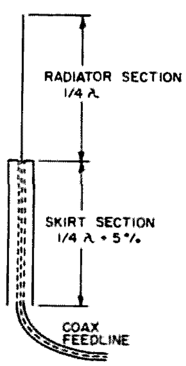


Fig. 1. Basic coaxial antenna. Making the skirt 5% longer than the radiator improves bandwidth.

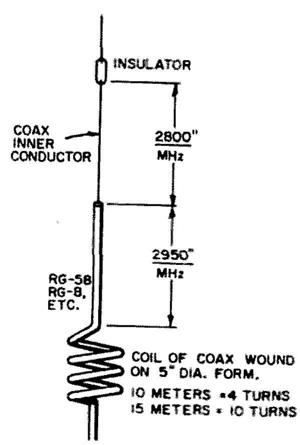


Fig. 2. "Limp" type of coaxial antenna. For best results, the decoupling coil resonance should be checked with a grid dipper.

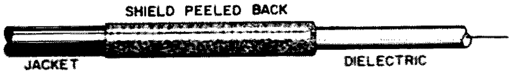


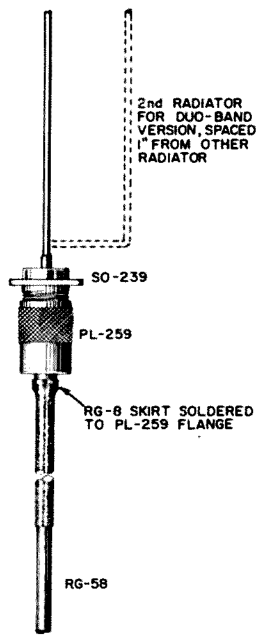
Fig. 3. Peeling the shield of RG-8/U back over the jacket makes a fine skirt—if you have a great deal of patience!

a more permanent installation, the use of a PL-259 plug and SO-239 receptacle should be used to make the joint between the radiator and skirt. The RG-58 can be connected to the PL-259 in the usual manner, using a reducer insert and the skirt soldered directly to the rear flange of the PL-259. A large solid or stranded conductor (the center conductor of the length of RG-8 from which the shield was removed or #14 copperweld) is soldered to the SO-239 to form the radiator section **(Fig 4)**.

After using an antenna of this type on 15 meters for some time, I decided to make a dual-band version for 10 and 15. My first thought was to place another skirt for 10 insulated from and over the 15 meter skirt and add a 10 meter radiator section in parallel with the 15 meter one. Although coax is available to do this type of construction, I first tried adding only the 10 meter radiator section. The SWR was low (1.7 to 1) on 10 and the antenna performed well enough that I completely forgot about adding the additional skirt. For perfectionists, however, RG-14 seems to provide the next usable shield size!

The coaxial antenna should, of course, be vertically mounted for an omnidirectional pattern. However, there is no reason why it can't be used horizontally also as a temporary

Fig. 4. Use of a PL-259 and SO-239 to make connection between skirt and radiator. Dimensions are as shown in Fig. 2.



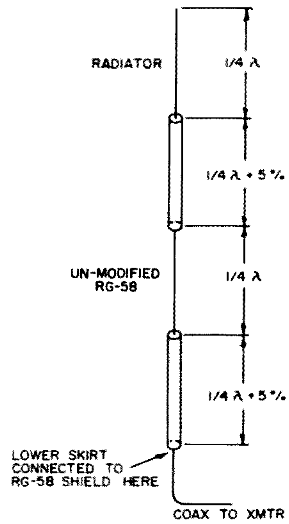


Fig. 5. Basic details of the double-coaxial antenna.

antenna. The pattern will then be basically the same as a center fed dipole at the same elevation. For experimenters who have a bit of space, there is always the double coaxial antenna which will further improve low-angle radiation **(Fig. 5)**. Note that the *lower* skirt is connected to the RG-58 at its *lower* end.

. . . W1DCG

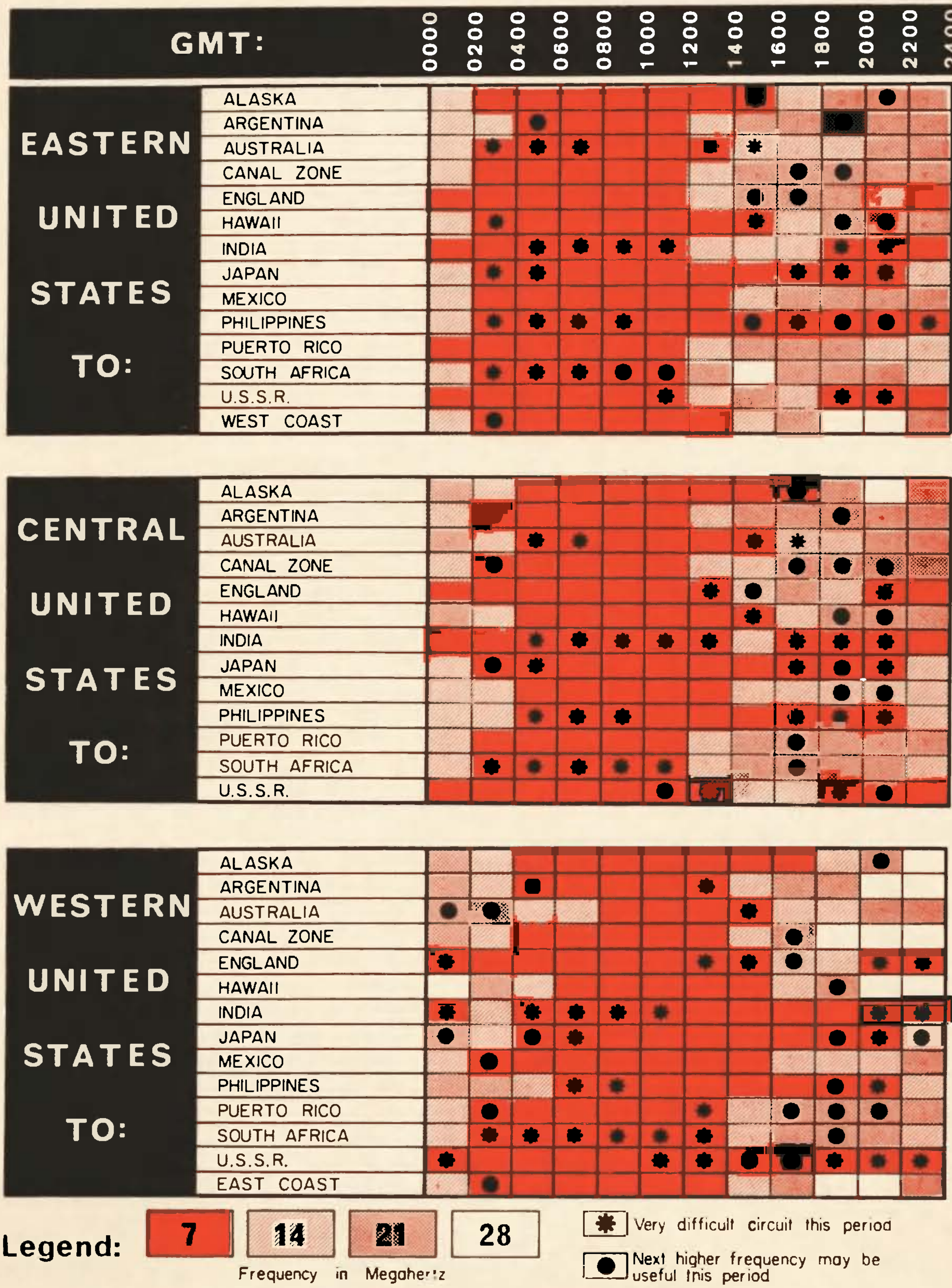
PROPAGATION

DECEMBER 1966

J. H. Nelson

DX CALENDAR

OPTIMUM FREQUENCIES HOURLY



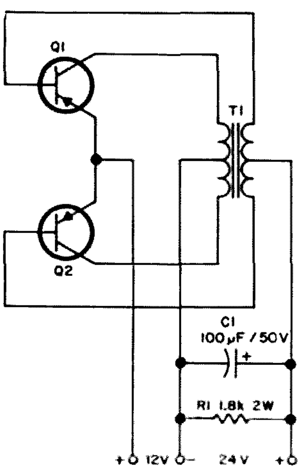
Richard Factor WA2IKL
115 Central Park West
New York, New York

Cheap DC To DC Conversion

Need about an amp at 24 volts in your car? Like to run your 12 volt radio in your Volkswagen? This is for you.

In mobile operation, it is frequently desirable to increase the battery voltage to some higher value. Although this article will specifically describe a unit for converting 12 V to 24 V, the circuit can be used for other voltages up to about 35 with a power limitation of about 125 watts. The particular unit described is being used to power a transistorized transmitter which wouldn't draw sufficient current with 12 V input. A smaller unit could be built to run a 12 V receiver in a Volkswagen, a larger one to power some of the surplus 28 V equipment on the market. The circuit is unusual in that it uses no rectifiers to change the ac to dc. In fact, it can be made to work with only three components!

When I said that the circuit uses no rectifiers, I was being somewhat misleading. In actual fact, the transistors that do the oscillating also do the rectifying. To see how this can come to pass, let's look at the circuit: Assume Q1 has just been turned on. There is a current in the upper half of the primary and 13 volts is being developed in each half of the feedback winding. Summing voltages around the circuit, we have 13 volts between A and B, −1 volt between B and C (because of the forward conduction of the emitter diode), and 12 volts (the supply voltage) between C and D. This gives a total of 24 volts between A and D. Although there is 13 volts developed in the other half of the feedback winding, it is not conducted because the emitter diode of Q2 is reverse-biased. When the core saturates, the current in the feedback winding reverses and turns on Q2.[1] The relative polarities remain the same, so there is 24 V dc between A and D, with the two transistors acting as a full wave rectifier. C1 is a filter ca-

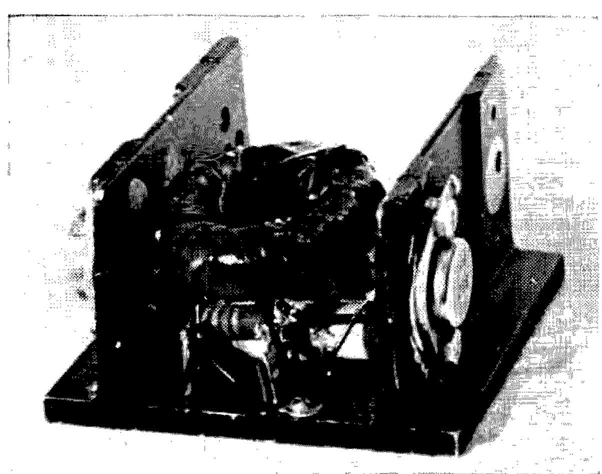


Q1,Q2 = GENERAL PURPOSE POWER TRANSISTORS

T1 = ARNOLD ENGINEERING NO. 5387-D4 .375" x .375" WITH 1.25" WINDOW

PRIMARY - 58 TURNS NO. 16, CT
FEEDBACK - 68 TURNS NO. 18, CT

Fig. 1. Schematic diagram of the 12 to 24 volt converter. It's good for about 1 ampere output at 24 volts.



Here it is. The heat sink came from Meshna (#223) and cost 45¢.

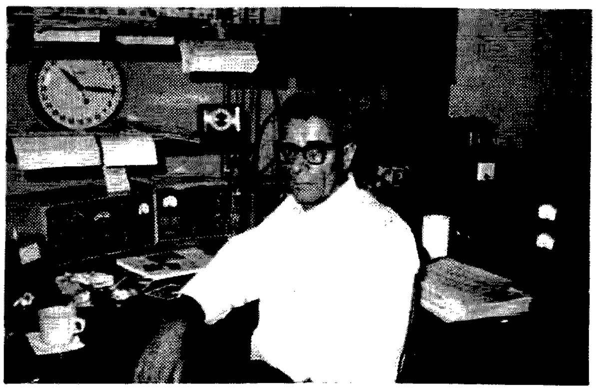
WTW News

Gay Milius W4NJF at his station in Norfolk, Virginia. Gay sent in the first 100 cards for WTW and earned WTW Certificate Number 1. Besides his DXing activities, Gay serves as stateside QSL manager for several harried DX stations.

Worked the World

Certificates issued to 15 November 1966

SSB WTW-200	1. Bob Wagner W5KUC
SSB WTW-100	1. Gay Milius W4NJF
	2. Bob Wagner W5KUC
	3. A. B. Hopple W3DJZ
	4. Bob Gilson W4CCB
	5. Jim Lawson WA2SFP
	6. Joe Butler K6CAZ
	7. Warren Johnson WØNGF
CW WTW-100	1. Vic Ulrich WA2DIG



Bob Wagner W5KUC qualified for the first WTW-200 Certificate when he sent in over 200 cards from countries worked since May 1st. A superb job of sorting out the rare ones; I wonder if that four element beam at 170 feet might have something to do with it?

pacitor and R1 is for easier starting under no load.

Transformer design can be found in an article by K2BQK.[2] I used the same core he did, which was an Arnold Engineering 5387-D4. If you wish to design for different voltages, remember that an extra turn or two should be added to the feedback winding to compensiate for circuit losses and voltage drop in the emitter diode. Most of the precautions normally taken for preventing high voltage damage can be ignored since there is no high voltage present. Both windings were wound directly on the core using the spaces between one winding for the other. The toroid was then covered with one layer of electrical tape and mounted by its leads on two terminal strips.

As can be seen from the schematic (**Fig. 1**), the entire dc output current flows through the bases of the transistors. Since the base current rating of most power transistors is one third to one fifth that of the collector current, the most economical use of this circuit would be to multiply the voltage about four times. If you need 24 V in a 6 V car, you're in luck. If you want 24 V from 12 V, the circuit will be just as efficient but part of the capability of the power transistors is wasted since the collector current must be limited to twice the base current. Since I paid 29 cents for the pair, I don't feel too guilty. If substantial power is required (over 30 watts), it is necessary to use auto radio transistors such as the 2N174 or 2N443. It is not recommended that the output voltage be greater than 35 unless you're sure that the transistors can withstand the voltage. It might be a good idea to put spike suppression capacitors from the base to the emitter of each transistor in this case.

To those of you to whom 24 volts in the car is about as useful as one tube of epoxy, you can build one to amaze and mystify your friends.

. . .WA2IKL

[1]For a more extensive theoretical development of the saturated core oscillator, see *D. C. Transformers,* B. E. Harris, W6ANU; 73, Oct. 65, P. 102.
[2]*Design and Construction of Mobile Power Supplies,* QST, April 1960.

Sam Kelly W6JTT
12811 Owen Street
Garden Drive, Cal.

Storage Batteries

Whether you use new or surplus storage batteries, this article will provide you with much useful data.

Storage batteries have been with us a long time. The Babylonians used them, but Allesandro Volta rediscovered the galvanic battery in 1800, and Gaston Plante came up with the first lead acid storage battery in 1859.

Until the advent of the solid state age, amateur use of storage batteries was usually limited to trying to re-charge the family car battery, or a once a year cumbersome field day exercise. Inexpensive surplus storage batteries have made really portable operation not only within the means of the average ham, but a real pleasure.

Two types of storage batteries are generally encountered on the surplus market: Lead acid, similar to your car battery, and alkaline storage batteries. The most common alkaline batteries are the nickel-cadmium and the nickel-iron (Edison) cells.

When buying a surplus battery carefully inspect the case for cracks. Check the terminal posts for looseness or signs of internal damage. Remember, there may be a good reason for Uncle Sam to sell the battery! Buy the most recent battery possible (if they are dated). The negative plates of dry charged lead-acid batteries tend to oxidize rapidly on exposure to moist air, so look for the ones that still have the seals over the filler plugs.

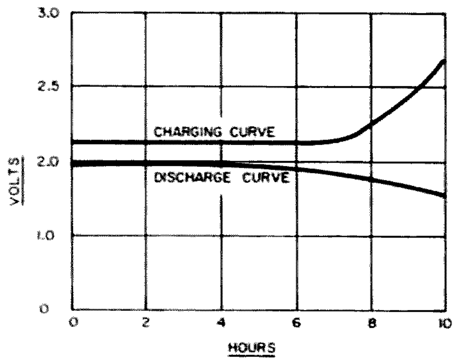


Fig. 1. Charge and discharge curves for lead-acid cells.

To get the best performance and life out of storage batteries requires careful maintenance and charging techniques. Dirt, corrosion and mechanical damage all shorten the life of a battery.

Terminal corrosion is best removed with a stiff fiber brush. After the corrosion is removed, wash the battery with water containing a mild detergent, and rinse with plain water. After replacing the connectors, coat the connectors and terminals with a light coat of cup grease or petroleum jelly to prevent further corrosion.

Connectors should be the proper size to provide maximum contact area with the battery terminals. Remember, lead has about 12 times the resistivity of copper! Always loosen and spread the connector for easy fitting. Never drive connectors on with a hammer or mallet as this may cause internal battery damage if it doesn't crack the case.

It is necessary to use completely separate sets of hydrometers and syringes for lead-acid and alkaline batteries. The alkaline cells are readily damaged by impurities, especially acid. The Army even insists that completely separate sets of tools be used.

Sam is an electronics engineer for the Interstate Electronics Corporation. He has a BSEL from California State Polytechnic College and enjoys high frequency ham construction.

The electrolyte should be kept at the recommended level. If electrolyte is lost by spilling, replace it with electrolyte. If the loss is due to evaporation or electrolytic decomposition bring the level up with distilled water. Don't use tap water as it may contain mineral impurities harmful to the battery.

Lead acid batteries

These are by far the most common surplus batteries. The small 6 volt Sniper Scope units, and the cased 4 volt Marine Corps walkie-talkie units are most desirable. Most of these batteries come dry charged. Dry charged batteries are activated by addition of sulphuric acid electrolyte. This is usually available at local battery shops. The most common specific gravity is 1.280. The electrolyte should be at least 60 degrees F before filling. Fill slowly until the electrolyte fills about half the battery. Allow the battery to stand for 15 minutes. Tap it gently several times during this period to release the trapped gas. Continue to fill with electrolyte to the operating level. The battery should then be placed on a constant voltage charge (2.5 V/cell) until it is fully charged.

Battery life is largely determined by the charge-discharge cycle, charging at too high a rate will cause the battery to heat up rapidly and gas excessively. This can damage the separators and buckle the plates destroying the battery. A temperature corrected hydrometer is desirable for checking electrolyte specific gravity during operation and charging. An approximate state of charge can be found from the specific gravity. For most high discharge rate batteries, a specific gravity of 1.280 represents full charge, and 1.100 completely discharged.

For constant voltage charging, the voltage should not exceed 2.75 volts per cell. For constant current charging the current should be approximately 10% of the rated battery capacity.

Alkaline batteries

Nickel-cadmium and nickel-iron (Edison) are the two alkaline cells commonly found on the surplus market. They have the same positive plate material and use the same electrolyte (Potassium Hydroxide).

Unfortunately, all of the Edison cells I have found in surplus stores have been badly damaged. Thanks to design changes in certain anti-aircraft missile systems there is a good supply of new, small nickel-cadmium cells. These cells are of two types, the hermetically sealed type containing electrolyte, and the

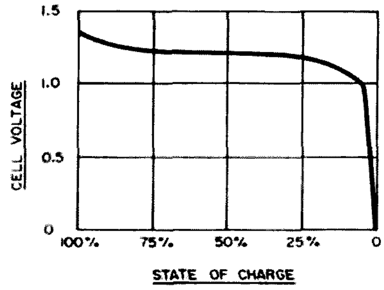


Fig. 2. Typical discharge curve for nickel-cadmium cell.

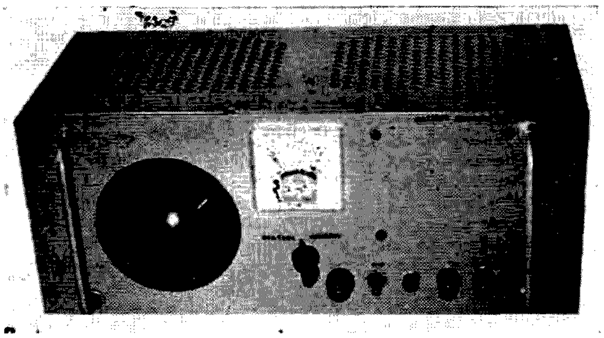
dry charged type. If you get the dry charged type you will have to obtain vent plugs to replace the shipping plugs or you will rupture the cases on charging. Vent plugs are packed in the carton with the cells, but they have a habit of getting lost in surplus stores.

The potassium hydroxide electrolyte can be obtained from three sources: 1, Surplus. The electrolyte is packed in cartons ready for use. Read the label carefully. It should have federal stock number FSN-6810-543-4041 printed on it. 2, Chemical supply houses. It can be ordered as a powder or in tablet form. Order potassium hydroxide, reagent grade and specify that it is for batteries. You will need distilled water to dilute it to the proper specific gravity. WARNING: Always add the potassium hydroxide to the water, never the water to the potassium hydroxide! Proceed slowly. The chemical reaction liberates heat which can cause the solution to splatter if you aren't careful. Both the chemical and the solution are highly caustic. They will do a fine job of dissolving skin. It is quite poisonous so store it carefully out of the kids reach. Mix according to the directions, or approximately 9 ounces of the powder to a quart of distilled water. The specific gravity of the solution should be 1.32. Check it with a hydrometer, *but* not the one you use for lead acid batteries! 3. Your local druggist can make up small quantities for you.

Fill the cells to the level mark, or just above the top of the plates using an electrolyte syringe or a large eye dropper. Tap and squeeze the cells to release the trapped air. Allow the cells to stand for at least 15 minutes before charging them.

A rule of thumb is to charge the cells for 15 hours at a rate equal to 10% of their rated service capacity (for a 10 amp cell the charging rate would be 1 amp for 15 hours). The final charging voltage will be 1.45-1.50 volts.

Since it is very difficult to determine the state of charge of these cells it is advisable to charge used cells in this manner before use.



Front view of the home-brew 10 A battery charger shown in Fig. 3.

After charging the cells let them stand two to four hours before adding distilled water (if necessary) to adjust the electrolyte level.

The cells are rated at 1.25 volts under nominal load. Open circuit voltage of fully charged cells runs about 1.33 volts. The voltage when loaded to the ten hour discharge rate ranges from 1.2-1.35 volts depending on state of charge. The state of charge cannot be determined by measuring the specific gravity of the electrolyte. One method is to measure the cell voltage under load. The standard ten hour discharge rate is normally used. Table 2 shows the approximate relation of cell charge to cell voltage. As you can see from figure 2, this is a very flat discharge curve. A more accurate way is to measure the current flowing into the cell when it is connected to a constant 1.50 volt source. If the current is less than 5% of the 10 hour rating you can assume that the cell is fully charged.

Paralleling of nickel-cadmium cells to increase the current capacity of the battery is not recommended. The internal resistance varies sufficiently so that it is difficult to prevent cells from over charging, failing to charge, and from reversing polarity.

Charging

Two methods of charging are commonly used for either lead-acid or alkaline batteries. They are the constant voltage and constant current methods.

The constant voltage method is the easiest to use providing the charger has adequate capacity. Initial charging rates for a fully discharged battery are high, running from 3-5 times the 10 hour rate for nickel-cadmium batteries, and 6 times the finishing rate for lead-acid batteries. The advantage of constant voltage method is that it is difficult to over charge the battery.

When using the constant voltage method on lead acid batteries you can take advantage

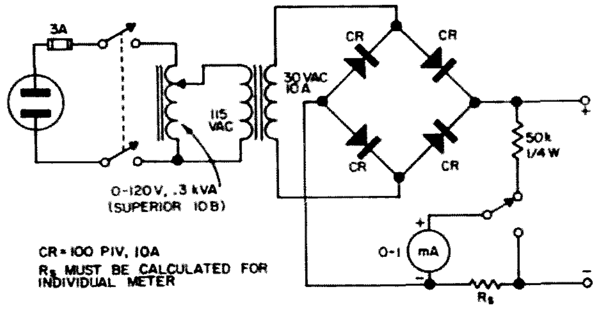


Fig. 3. Battery charger schematic.

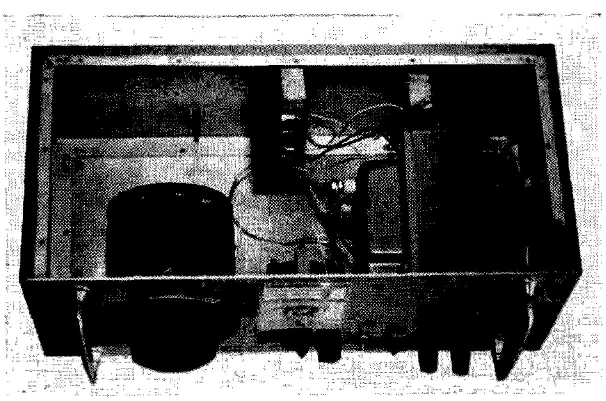
of the "quick charge" technique used by service stations. A high percentage of the charge can be put back into the battery in a short period of time—if you are careful. The rule is to keep the charging rate (in amperes) less than the number of ampere-hours out of the battery. For example, if you have used the battery for two hours at a five amp rate you can charge it at a 10 amp rate.

When using the constant current method care must be taken to prevent over charging. For lead acid cells this can be done by checking specific gravity of the electrolyte. For nickel-cadmium cells charge at the rated current until the cell voltage reaches 1.45-1.50 volts.

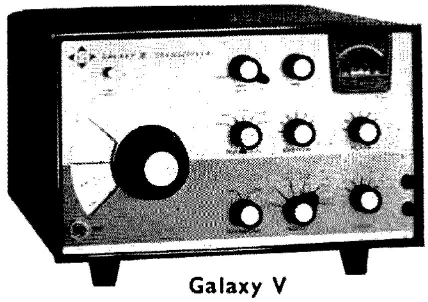
Fig. 3 is the schematic diagram of the battery charged. It is a simple bridge rectifier device built into a case made from a BC-375-E tuning unit. A Variac provides continuous voltage adjustment, while the transformer provides isolation and voltage step down. All components except the rectifiers are mounted to the front panel. The rectifiers, on insulated heat sinks, are mounted to the cabinet. The meter serves a dual purpose, reading either voltage or current.

A three wire power cable is used to provide added safety. This unit was built for less than half the cost of a 10 amp commercially built home type charger.

. . . W6JTT



Interior of the battery charger showing parts layout.



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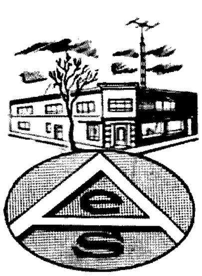

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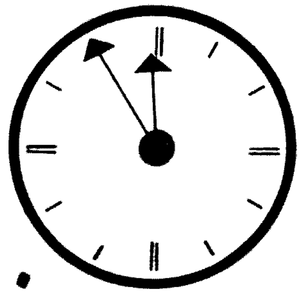

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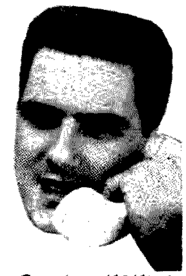

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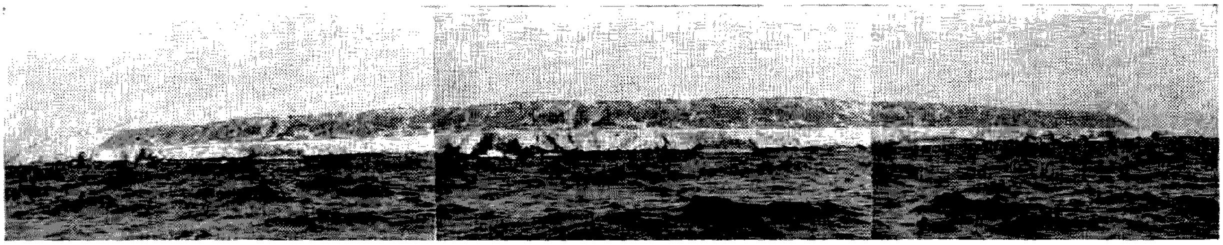
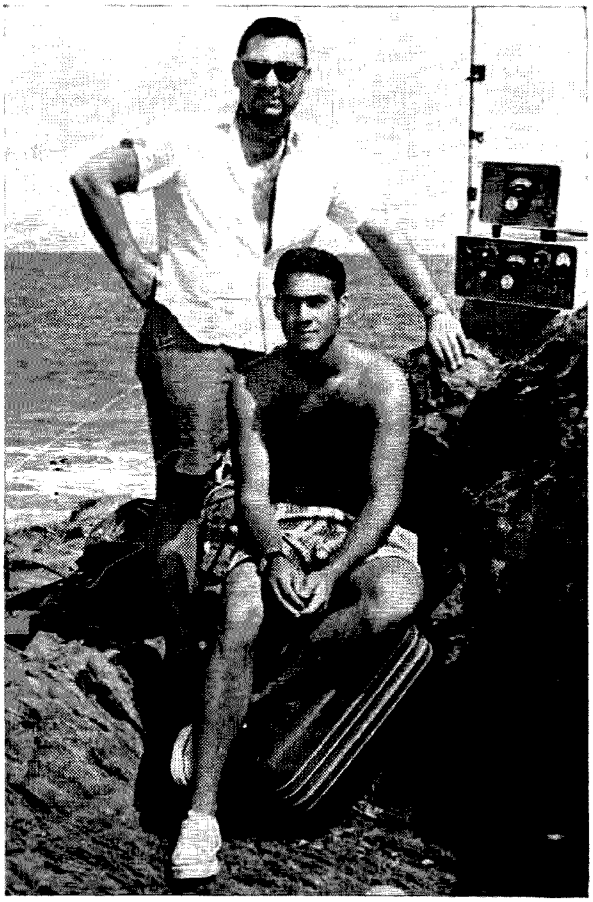


Wayne Green KC4AF

Navassa Revisited

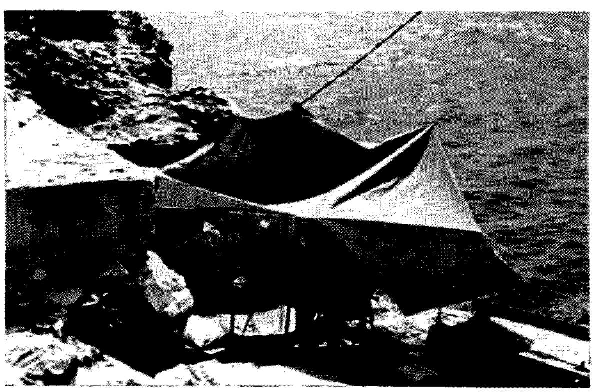
For about two years now I've been trying to get the U.S. Coast Guard to give permission for me to return to Navassa Island for a short DXpedition. They have steadfastly refused, giving no real reason for the refusal. Dick, WØMLY, has been after them about this, too, and he believes that the problem is a 75 meter phone ham among the top echelon of the Coast Guard who has decided that DXpeditioners can just drop dead. I find this hard to believe, but I do admit that we have been faced with what has seemed like a senseless decision to keep DXpeditions off Navassa.



Don W9WNV (standing) and Herb K1IMP

Navassa is a small island about one mile in diameter lying between Jamaica and Haiti in the Caribbean. It has no beach and can only be mounted by climbing a very difficult steel-rope ladder set in a slight indentation in the otherwise unbroken cliff that runs all around the island. Fortunately for us hams the Coast Guard has a winch set up. Back in 1958 when six of us mounted Navassa (with Coast Guard permission) we hauled our gear up with this winch. At that time I got the call KC4AF. The station was set up and operated for four days and made over 7000 contacts during that time.

No one has set up on Navassa since our little visit in 1958 and by now quite a few fellows "needed" Navassa. Don Miller W9WNV decided not to wait around for the Coast Guard to give its permission. He and Herb Kline K1IMP stopped off there for a short visit and signed K1IMP/KC4 instead of getting a regular KC4 call, which is only available with Coast Guard permission. We'll get the full story of their visit later, but I understand that it didn't take the Coast Guard long to send a plane down to see what was going on. We'll all be interested in hearing about how the CG went about prying them loose from the island while the pileups were still in progress.

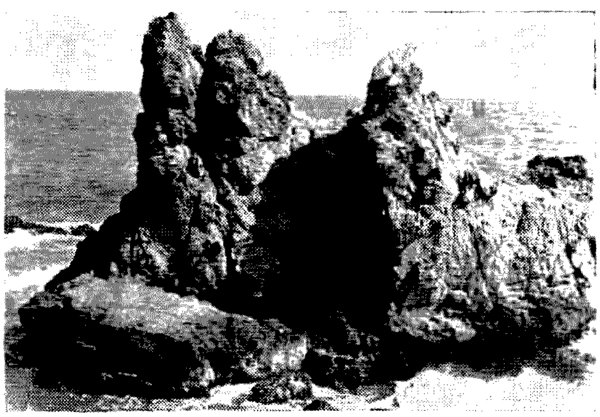


Operating position on Navassa

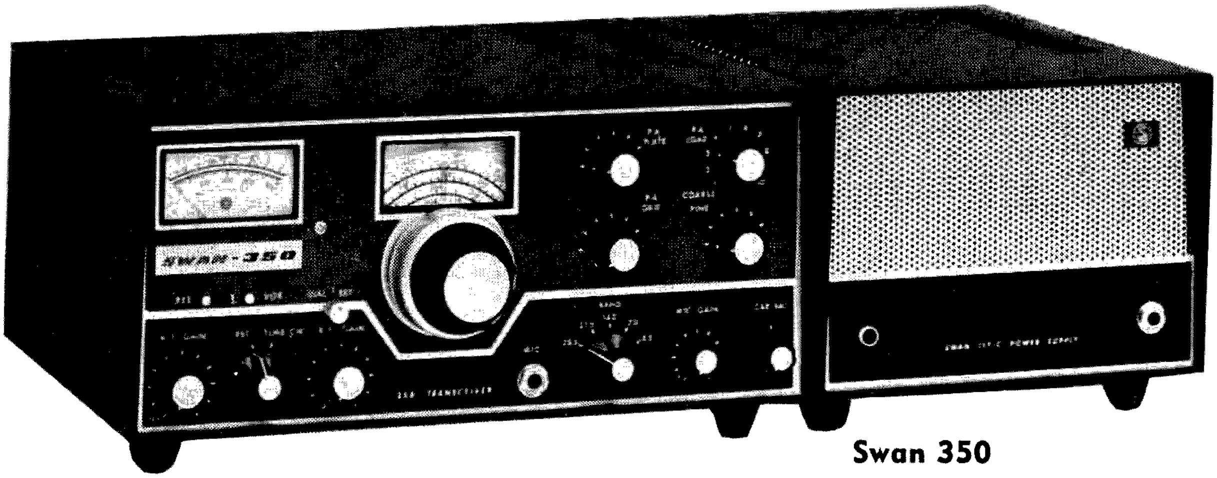
Notice the defaced government property. For shame!

Don reported that he looked all over for my W2NSD call letters on the landing spot so he could blank them out with his. Heh, heh! I didn't put my call there, just on the photo I printed on the cover of CQ at the time. Don came armed with a big bucket of paint and I see by the photos that he and Herb did put their calls all over everything. Tsk, tsk, fellows . . . defacing government property.

. . . Wayne



This is a shot on the St. Peter and St. Paul Rocks (PYØXA), another recent Miler DXpedition



Swan 350

Happiness Is A Swan On Christmas

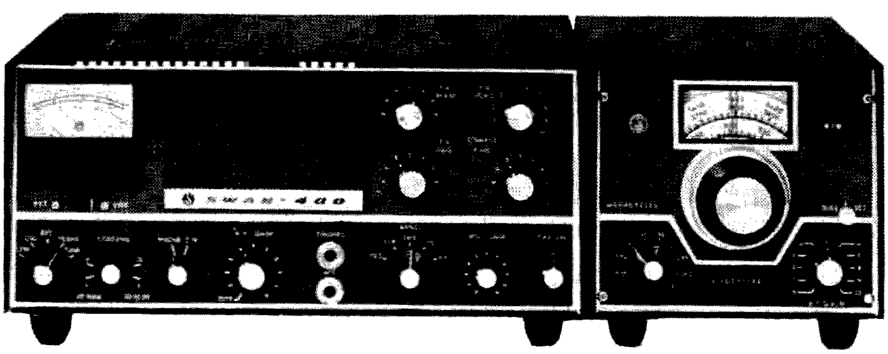
I have written a great deal about Swan in the past year, my ads having appeared in 73 Magazine, and other magazines as well. Suffice to say that I consider Swan to be the overwhelming choice in America today for small transceivers More Swans have been sold than all of the other brands put together and this is not an exaggeration. The fundamental reason why America has taken to Swan is the fact that you get the most for your money in this set—the maximum frequency coverage, the most power, and the greatest choice of options on accessories. Swan is an attractive piece and Swan sounds good when you listen to it on the air.

We carry the complete Swan line, and because we keep in close touch with the factory, we can introduce new models to the public before other distributors can. For example, we have sold more of the Model 250 6-meter sideband transceivers than any other dealer as of October 1966, and we will shortly have the new 6-meter kilowatt linear with 2000 watts of PEP. This will sell at $543. with tubes.

The largest seller continues to be the model 350. This is a 5-band complete-coverage transceiver providing AM, CW, and sideband operation. Its companion is the Model 400. Let me describe the difference between the two. The 350, with an appropriate power supply is a complete package requiring only a microphone and a suitable load. The Model 400 requires an external VFO in addition to a power supply, microphone and load. In other words, the 350 has a VFO; the 400 does not. The 350 was designed to be a basic set, providing the means for the owner to add the accessories of his choice. For example, with the 350 you can purchase a calibrator at $19.50. This will enable you to have 100kc markers throughout the set's spectrum and it is easy to install—takes only about an hour. If you are one of those rare fellows who wants to defy convention and operate on the opposite sideband from most of the gang, the other sideband kit is available for only $18. Ordinarily, of course, the 350 comes through with lower sideband on 80 and 40, and upper sideband on 20, 15, and 10. By contrast, the Model 400 includes the calibrator and the opposite sideband and a built-in speaker. You might think of the 400 as being a deluxe version of the 350. The price of the 350 and the 400 is the same—$420 each. Oh yes, I forgot a most important part—the transistorized VOX. The model 400 includes the VOX, but it is an accessory for the 350 and costs $35.

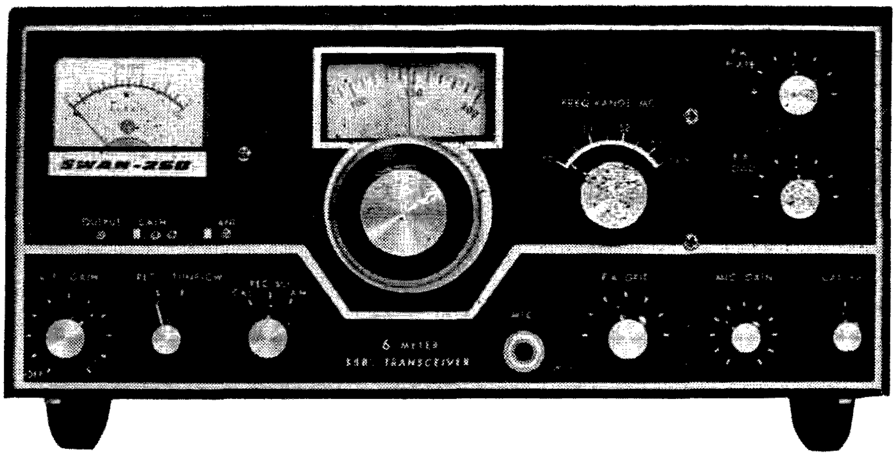
If you want to do it up brown and get the 400, there is a choice of three oscillators or VFO's. You can get the Model 410 which is essentially the same VFO as is normally found in the 350. This costs $95 but, unlike the 350, it provides for 8 ranges of 500 kc each with calibration better than 5kc on each band. The second is a crystal-controlled MARS oscillator which will enable either the 350 or the 400 to reach any frequency from 3 to 30 megacycles, and is available for only $45, less crystals. The third oscillator is the mobile model 406B selling at $75. This, in reality, is a control box and VFO combination. When used with the 400, it permits operating the transceiver in the trunk of the car and the controls themselves can be conveniently mounted underneath the dash. It is very small and compact. It includes an RF gain control, a jack for the microphone, etc. Another accessory is the remote control kit for trunk mounting of either transceiver. This is only $25.

One of the specific reasons why hams like Swan is the flexible design of the power supply. The standard supply, their model



Swan 400

Swan 250



117XC, sells for $95. It includes a small speaker, a phone jack, and a neon indicating light, and, of course, it matches the style and dimensions of the 350 and 400. It may be used with either the 350 or the 400 and, by the way, many of you hams have learned to your disappointment that you cannot easily make a supply to do this specific job. The reason why the Swan supply is unique is that it has the ability to deliver a hundred volts of bias at 100 milliamperes. Additionally, it provides 12 V DC at 250 mils for operating relays and, of course, the conventional 800V and 300V. But don't let me stop here. The Swan concept on power supply engineering makes it possible for you to use this same supply if you want to operate mobile. All you need do is to purchase their Model 14X for 12V grounded negative applications or their Model 14XP for grounded positive cars, and then plug this module into the back of the standard power supply. Some of you will only want to operate mobile, especially those who are on the road all of the time. Swan has the answer: Don't buy their console with the speaker and phone jack. Just buy the DC module and the basic AC supply. This is their model 14-117 and costs only $130, and, if you start out like this and later wish to convert, you can buy the matching console for only $20.

I think, when you evaluate the cost of other manufacturers' products, you will find it less expensive to put the Swan in the car to start with than other brands and certainly far less expensive to get a combination supply.

The 6-meter 250 has created a storm here in the East and more and more model 250's can be heard nightly around 50.110. The price on the model 250 is only $325 which makes it possible for the average ham to get on side band for less than the price of AM models of comparable power. Indeed, a one popular AM unit provides only 48 watts of input at a price of $367. Here is a chance to get 250 watts of sideband operation for only $325 plus the price of a Swan supply. The Swan 250, like the other Swan models, uses a transistorized VFO. The basic oscillator is multiplied by three, isolated and amplified, and then when added to a 10.7 megacycle filter produces output at the desired 6-meter frequency. By going down to 13 megacycles, Swan achieves a relatively high order of stability. They have a separate control for audio gain and RF gain. They have a noise limiter for impulse-type noise such as spark plugs or static, and they have available a special calibrator for 6-meters. This uses a 500kc crystal and can be added for only $19.50.

Swan's Mark I linear complete with tubes is $543. It is styled as per the accompanying photograph to match the appearance of their transceivers. The unit will operate cool with a pair of 3-400Z's and produce a maximum rating of 2000 watts PEP input. In other words, you can run a thousand watts of DC input. This is a modern air-cooled unit with solid state rectifiers engineered as a mate to the models 350 and 400.

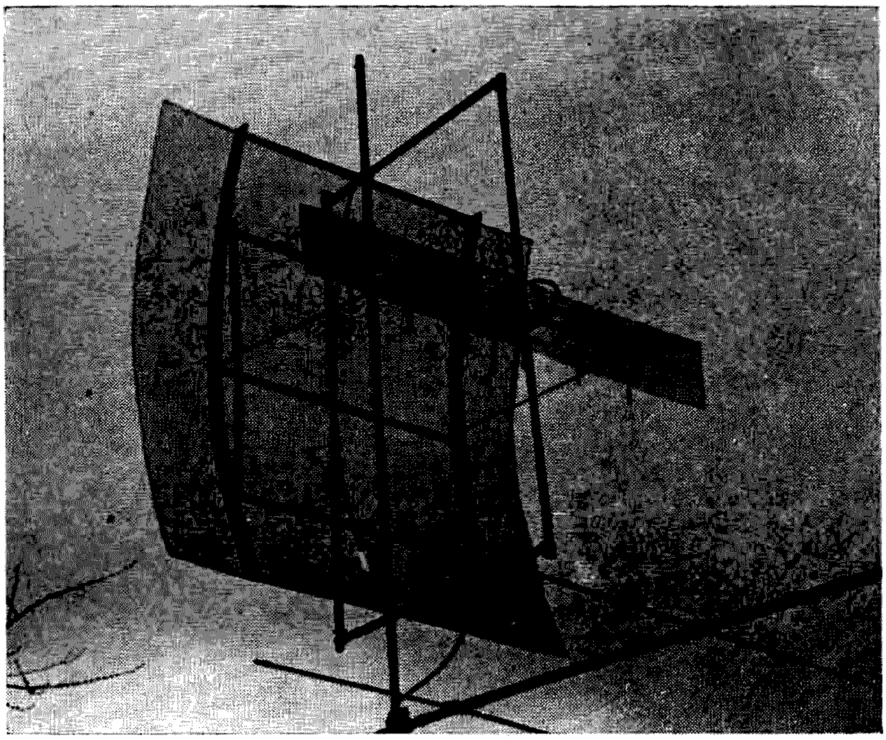
We have the other Swan products in stock including their antennas, and we hope to have their model 500 transceiver when it is first brought out. Swan products are guaranteed both by the manufacturer and ourselves and we are proud to state that without exception all Swan service has been accomplished in our own well-equipped shop. Swan transceivers have a velvety smoothness about them; they are easy to tune; they are engineered to provide the maximum safety for their finals, and if you use them into a proper load, you will have one of the best pieces of communications gear available.

Swan Mark I Linear

HERBERT W. GORDON CO.

Woodchuck Hill, Harvard, Mass., 01451

Telephone 617-456-3548



Cylindrical parabola.

Jim Kennedy K6MIO
2816 E. Norwich
Fresno, Calif.

Illumination and Parabolic Antenna Design

Most moonbouncers are using or intending to use parabolic reflectors as antennas in their attempts to further the boundries of amateur radio. Here's some discussion of their problems from a well-qualified author.

On frequencies above about 300 MHz, high antenna gain becomes increasingly more difficult to achieve with multi-element arrays. This is due to a number of factors which are the result of a common cause—the shortness of the wave length.

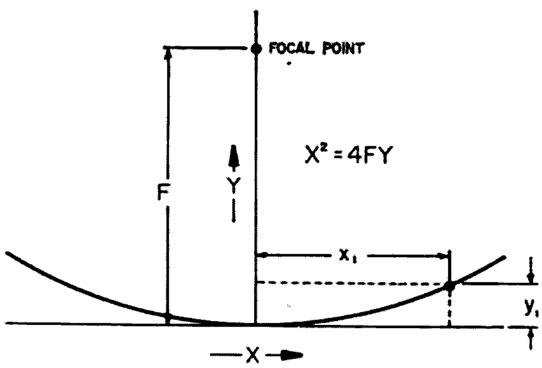


Fig. 1. Basic parabolic diagram.

In the UHF spectrum, the practical level of antenna gain attainable with a colinear broadside array reaches a limit around 20 dB. Above this value the number of elements and the associated feedline phase problems multiply at a fearsome rate. Higher gains are certainly possible, but difficult to achieve. The same is the case for the various other types of arrays in common use by amateurs today.

It is because of these same problems that the use of parabolic antennas has become so extensive in the UHF and microwave region by the commercial services. The parabolic reflector's ability to focus the energy that strikes its surface to a small point reduces the number of elements required to a very few.

As activity on UHF has increased there has, naturally, been an increase in interest in the various types of parabolic reflectors. This situation has been further inhanced by the

occasional appearance of parabolic reflectors on the surplus market.

Parabolic reflectors

Basically, there are two types of parabolic antennas: the cylindrical and the paraboloid of revolution.

The cylindrical parabola is simply a sheet of reflecting material bent into a parabolic shape in one plane only, and is the easiest to construct. It concentrates all the reflected energy on a thin focal line. The feed antenna must be an array of radiating elements fed *in phase* and placed on this focal line. There should be a half wavelength array for each half wavelength of reflector length in the non-parabolic plane.

The paraboloid of revolution is the more familiar type of reflector. Here the surface has a symmetrical parabolic shape in all planes. As this type concentrates all the reflected energy to a single point, it is the easiest to feed. It requires only *one* feed antenna at the focal point, rather than several on a line.

In either case the distance to the line or point of focus is called the focal length and is derived from the general parabolic equation:

$$X^2 = 4FY$$

so that

$$F = X^2/4Y$$

where F is the focal length and X and Y are the base line and deviation from the base line respectively.

Illumination

One of the most important considerations in designing a dish or putting a surplus dish into service is that of illumination.

In order to make proper use of the reflector, it is very important that the feed antenna place all of the available rf energy on the reflecting surface. This process has been likened to light optics and, hence, it is, quite appropriately, described as "illuminating" the dish with rf.

The ideal situation would be a feed antenna which produced a beam pattern such that the rf was distributed evenly over the entire dish surface but stopped, completely, just at the edge of the dish, so that no energy "spilled over."

If the beam is too narrow, all the energy will strike the dish, but the portion illuminated will be less than the full dish and hence, the gain is reduced. The result is the same as using a smaller dish in the first place.

Should the beam pattern be too wide, the entire dish will be illuminated, however, part of the energy will miss the dish. This spilled over energy is lost and, hence, the gain is reduced. Spill over also causes side lobes, as the antenna will radiate energy in some other direction besides the main beam out the front of the dish. **Fig. 2** illustrates these three situations and shows antenna patterns that might be expected.

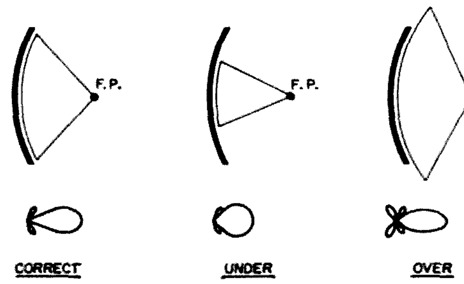


Fig. 2. Various degrees of illumination and typical associated overall antenna patterns.

It is well to recall that the ideal situation described—a perfectly uniform beam which suddenly and completely stops just at the edge of the dish—is a physical impossibility. In reality, the intensity of the beam pattern of the feed antenna will taper gradually, rather than remain uniform or stop suddenly. This itself generates some other problems which will be taken up later, but, for the moment, the ideal situation is of help to demonstrate the basic problem of illumination.

It can be seen then, that the angle between the focal point and the edge of the dish assumes a degree of considerable importance. If the angle is either too great or too small for the pattern of the feed antenna, the maximum available gain is not achieved.

Suppose, for example, you wished to build a dish 10 feet in diameter. Let us further suppose that you have a feed antenna which will produce an "ideally" shaped pattern 110° wide. It will then be necessary to select the dish curvature so that the focal length will be such that the 110° angle will just touch the edges of the dish. The required focal length in this particular case is 5 feet. Just how this value of focal length might be obtained will be discussed in some detail later.

As it was mentioned earlier, the beam pattern of a *real* feed antenna does not have

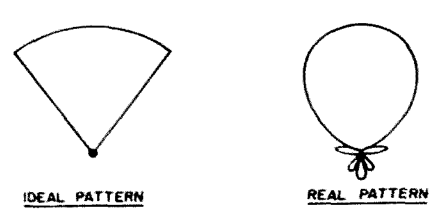


Fig. 3. Typical ideal and real dish feed patterns.

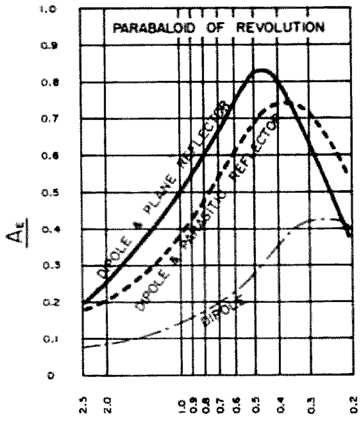


Fig. 4. Effective aperture versus focus-diameter ratio for the paraboloid of revolution.

"ideal" shaping. The intensity is not uniform and its boundaries are not sharply defined. The intensity tapers off gradually and boundary limits can be assigned only arbitrarily. (A real and the ideal feed antenna pattern are compared in **Fig. 3.**) This situation complicates the selection of the focal length or feed pattern considerably.

The feed antenna's tapering field means that energy reflected at the edge of the dish strikes the feed antenna at an angle where its response is lower than maximum and hence, this energy will be weaker than if the same amount of energy had been reflected by the central portion of the dish. Consequently the tapered feed field causes the gain of the dish to be less than the ideal value. This effect is the same as under illumination, except that it occurs gradually.

The fact that the tapering field has no sharply defined boundaries means that there is likely to be some energy radiated at wide enough angles so that it will miss the dish and hence, become spill over energy.

The final value of the desired illumination angle is a compromise under illumination and spill over. The whole approach is, in turn, a compromise between maximum gain and minimum sidelobes.

In approaching parabolic design from the amateur's standpoint it would seem that the latter compromise should be to design the antenna for maximum possible gain with no consideration for sidelobes, except that they be low enough not to affect the gain of the antenna (−10 dB or more). This lays the ground work for the first compromise.

While it is not the purpose of this article to delve very deeply into the mathematical aspects of this problem, and, we have, in fact, already side-stepped some of the physics involved, for the sake of simplicity (mainly the

question of diffraction and its relation to sidelobes), for those who enjoy such discussions, an attempt will be made to provide some insight as to just how the gain parameters, to be given shortly, are derived.

The nomenclature in this area of physics seems to be somewhat less than universal and often ambiguous, as many of the same terms are used by different authorities, but often to describe different things. The liberty will therefore be taken to add to this confusion by inventing two more names—taper factor and spill over factor.

Deriving the taper factor is a bit complicated and it will not be attempted here. This factor is the one which expresses the efficiency of the reflector in view of the tapering of the field toward the edges of the dish.

The spill over factor is merely the ratio of *power* incident on the dish to the total power radiated by the feed antenna.

The product of these two factors is the overall efficiency or *effective aperture* (to use another of those ambiguous terms), A_E, of the dish and, as such, is the factor by which the actual gain of the dish is related to the ideal gain of the dish. It will be seen that this factor will vary up to maximum value of about 0.82, in theory, at least.

It is probably apparent from this discussion that the exact *shape* of the feed antenna curve will have considerable effect on the results obtained with a given dish. As the shape of the curve varies with different feed antennas, the parameters will not be the same for different types of feeds. It is also true that the parameters for a paraboloid of revolution and a cylindrical parabola are somewhat different.

In **Figs. 4** and **5** the effective apertures for the two types of parabolics are plotted for various types of feed antennas as functions of the ratio focal length to dish diameter, after the derivations by Fradin.[1]

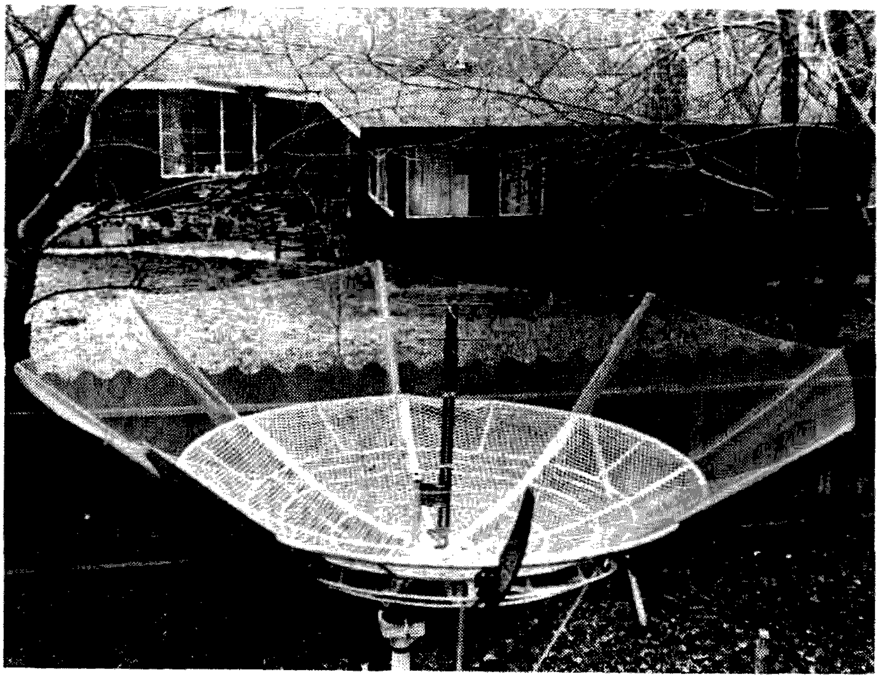
As the derivation of the various plots is somewhat involved, only three types of feed antennas are considered here. These are, however, the most common types; the dipole, the dipole and parasitic reflector, and the dipole and screen or plane reflector. A rule of thumb approach for other feeds will be given shortly.

The discussion of illumination has, up to this point, been in terms of proper feed angle, however, as it greatly simplifies the actual design of the dish, **Figs. 4** and **5** are given in terms of the proper ratio of focus to diameter which gives the proper angle for the desired feed type.

It will be noticed that the maximum effective aperture attainable in a paraboloid of revolution with the given feed types is in the neighborhood of 0.78 using a dipole and parasitic reflector. This occurs when the F/D is about 0.44. This is very nearly the maximum value attainable with any practical feed. A very carefully designed waveguide horn feed do only slightly better.

It will be noted that for simple feed types, the cylindrical parabola actually can perform slightly better than the paraboloid of revolution, as it turns in a value of 0.82 with a dipole and screen reflector when F/D is around 0.5.

1. A. Z. Fradin, *Microwave Antennas*, Chap. 3, 7.



Paraboloid of revolution —the common dish.

Another interesting feature of this reflector type is that the simple dipole can produce an effective aperture as high as 0.7, if the reflector is "wrapped" around it with a F/D of 0.08 or so, whereas, the simple dipole can produce no more than 0.37 with a paraboloid of revolution for any F/D. The reason for this lies in the fact that the paraboloid of revolution has its illumination tapered in all planes and hence, is in a sense less efficient than the cylindrical parabola which need only be tapered in one plane only. It serves the purpose of a simple passive reflector in the non-parabolic plane. It should rather be noted, however, that this apparent profit in efficiency is bought at the expense of complexity in the feed antenna as a large antenna of this type which requires a number of dipoles in phase along the focal line rather than one dipole at the focus point as in the case of the paraboloid of revolution.

The sidelobes for the maximum gain conditions for both types of reflectors are on the order of −16 dB which should be most acceptable for practically any amateur application.

If some other type of feed is used which produces patterns different from the examples given (for instance, a wave guide horn), the optimum effective aperture will be realized when the feed antenna field intensity is about −5 dB at the *angle* corresponding to the edge of the dish. If the field intensity of the antenna feeding a paraboloid of revolution is not the same in both planes, the angle should be such that the average of the two intensities is about −5 dB. This is only approximate, but it will work well for most conventional feed systems.

It should perhaps be clarified, in this respect that there is a difference in the nomenclature between the presentation here and those found in some other sources. It has been indicated here that the field intensity of the feed should be about −5 dB for maximum A_E and gain. This is to say that if an ordinary polar field pattern plot is made on the feed antenna by rotating it and noting intensity readings at a fixed point some distance from the antenna, the maximum A_E will ordinarily occur when the dish subtends an angle equal to the −5 dB beamwidth of that plot. However, this −5 dB is *not* the field intensity actually incident *on the dish surface itself*. The power from the feed must travel further to reach the edge of the dish than it does to reach the center and hence, the actual feed intensity on the dish surface, due to the inverse square law, as well as the original feed pattern, is around −8 to −10 dB. In as much as the −5 dB beamwidth of the feed antenna is any easier quantity to measure in the field, this approach has been suggested here for designing feed systems other than the types stated.

Designing the antenna

To use the effective aperture graphs to design a new antenna, one must decide what type and of what diameter the dish is to be and then, what kind of feed is to be used. Then multiply the diameter by the F/D which corresponds to the maximum effective aperture for that feed type and you have the focal length desired.

At this point you plug the focal length, F, into the previously mentioned formula for a parabola

$$X^2 = 4\ FY$$

and solve for the various Y points and you have the measurements of the dish.

For example: it was desired to build a cylindrical parabola 8 feet square. The diameter in the parabolic plane was, then 8 feet (the diameter in the other plane is superflous to the effective aperture). It was desired to use a dipole and plane reflector array as a feeder, hence, from **Fig. 5** the optimum F/D is about 0.5. As

$$0.5 \times 8 \text{ feet} = 4 \text{ feet}$$

the focus is established as 4 feet.

The general parabolic formula then becomes:

$$X^2 = 16\ Y \text{ or } X^2/16 = Y$$

and, supplying values of X for every foot out to the 4 foot mark we make table or graph, as in **Fig. 6**, showing the curve of the dish (in actual practice 6 inch intervals were used). All that now remains is to construct a dish with this curve.

Such an antenna was actually constructed and was described in detail in an earlier article.[2] This antenna did, in fact, perform very nearly as predicted, having side lobes that measured almost exactly −16 dB and an effective aperture in the neighborhood of 0.70 or about 85% of the predicted value.

On the other hand, if one wishes to put an already constructed dish, such as a surplus unit, into service, it is necessary to measure the dish to find its diameter and corresponding X and Y values. The X and Y values at any point may be plugged into the parabolic formula to provide the focal length:

$$F = X^2/4Y$$

Now that both the diameter and focal length

2. Jim Kennedy, "The Big Sail," *73 Magazine*, (August, 1965), 50.

are known the F/D of the dish is known. We may now refer to the appropriate graph and select whichever feed system provides the greatest effective aperture and, of course, the graph tells what that value is.

For example: a surplus paraboloid of revolution obtained which was 8 feet in diameter. At the edge of the dish ($X = 4$) the Y value was 16 inches or 1.33 feet, as

$$F = X^2/4Y = 16/4 \times 1.33 = 3.33 \text{ feet}$$

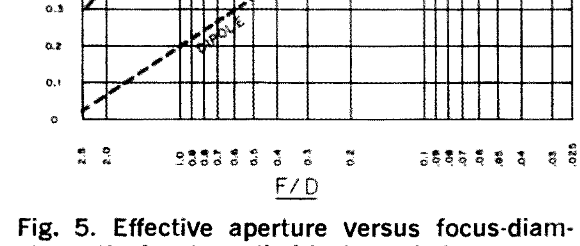


Fig. 5. Effective aperture versus focus-diameter ratio for the cylindrical parabola.

The focal length was 3′ 4″, and F/D = 3.33/8 = 0.415. Referring to **Fig.** 4 we find that the dipole and plane reflector will produce the maximum effective aperture for the F/D and this aperture should be around 0.77.

An example of a further applications: it was desired to enlarge the above antenna to 13 feet; if this could be shown to be worthwhile. The X and Y values for the new portion were plotted and it was found that the new F/D was 0.25, that is, the feed would lie on the same plane as the mouth of the dish. At this F/D, the graph shows that the best feed is now the dipole and parasitic reflector and that the effective aperture is about 0.62.

As the new dish was bigger but also less efficient, it remained to be seen whether there was any advantage in enlarging the dish. The gain of a dish is proportional to the product of the area and the effective aperture and, as the area is proportional to the square of the diameters, the ratio of the gains was:

$$\frac{(13)^2 \times 0.62}{(8)^2 \times 0.77} = 2.1 = +3.2 \text{ dB.}$$

Therefore, enlarging the dish would more than double the gain and hence, in this case, the modification was well worthwhile.

x	0'	1'	2'	3'	4'
y	0"	3/4"	3"	6 3/4"	12"

Fig. 6. Table showing x and y values computed for various points along a parabola with a 4 foot focus. See Fig. 1.

Gain

As just mentioned the gain of a dish is proportional to the area of the reflector times the effective aperture. In precise terms the gain over an isotropic radiator is given by the formula,

$$G_I = A_E\,(12.6)\,A/\lambda^2$$

where A_E is the effective aperture, A is the area of the dish, λ is the wave length in the same units as A, and G_I is a power ratio, not dB.

The gain in decibels is given by

$$G_{dB} = 10 \log_{10} G_I$$

The gain of the dish over a dipole is 2.2 dB less than that over an isotropic radiator.

The maximum values of A_E and, hence, gain derived here are somewhat higher than values generally found in many of the handbooks and other sources in common use. It was found that while many readily admitted that the effective aperture was variable and was usually between 0.5 and 0.7 of those checked few mentioned why and not mentioned how. Many of the gain formulas and graphs in these sources are based on an A_E of 0.55. This value is commonly used in radar systems. It is achieved by slightly under illuminating the dish in order to reduce the sidelobes somewhat. This is done at some expense in gain. Furthermore, there are a number of factors which will, in practice, reduce the actual gain or A_E from the theoretical value derived from the graphs.

The manufacturing tolerance of the dish has a definite effect on antenna gain. If the RMS tolerance remains under 0.1 wavelengths, the gain should be within 1 db of the maximum value.

It is well, too, to caution that the A_E values shown are presented with the assumption that there are no ohmic losses in the feed system and that the reflector is a perfectly reflecting surface. *Neither of these factors will affect the value of the optimum F/D*, but it will act to lower the actual A_E value by reducing the overall gain.

Ohmic losses in the feed system can be held to a quite small value by the usual methods of using low loss materials such as copper with silver plating or a lacquer coating in the radiating elements.

The reflectivity of the dish surface is a function of its surface conductivity and its RF porosity. A high conductivity metal like silver or copper will produce a superior reflector to a metal like steel or aluminum, however, solid silver dishes are rather rare and steel and aluminum are quite reasonable substitutes. The surface should be protected from corrosion by a coat of paint or lacquer or be of galvanized or dipped material.

Porosity becomes a factor when the reflecting surface is a meshed material such as hardware cloth. If the openings in the mesh are 0.25 wavelengths or less the porosity is practically nil and practically all of the power will be reflected; whereas, if the openings are of the order of 0.5 wavelengths or more, the porosity is nearly 1 and almost all of the power will pass through the screen rather than be reflected by it.

All these factors operate to lower the gain and A_E though, with careful design, they can be held to a minimum and actual A_E's in the range of 70 to 80% of theoretical values in Figs. 4 and 5 should be attainable.

. . . K6MIO

Gus Browning W4BPD
Cordova, S.C.

Gus: Part 18

In the last episode I was on my way to the Chagoes and the ill-fated /VQ8 operation. I use the term "ill-fated" loosely here since as explained in my last episode I think I was about as legal as was possible at that time. I did not know I was being stabbed in the back by a brother ham (the word "brother" is used loosely, too!). I hear over the air that Harvey Brain is thinking about leaving VQ9. Well, let's wait and see about that before we ah–ah –ahh——. Anyway I was on the way to VQ8C and I had a FB trip there with my fish-catching antenna.

The Chagoes, you know, consist of some 200 islands. We passed many very small ones, each covered with coconut palms loaded with coconuts. Looking at the captain's charts I could see that the ocean was very shallow in many places so the captain had to do some real navigating. We landed at Diego Garcia, an island some 20 miles long and a mile across. I was surprised to see how much work they had done to make the loading of copra efficient. A long concrete dock projected out into the bay a few hundred feet. The ship we arrived on was anchored out in the deep channel. Copra was boated to it from the long pier. We went ashore and I presented my letter of introduction from the island's owner. From then on I was treated as a guest—tea and crumpets any time and plenty of help to assist in erecting my antennas. A shack was prepared for my use at the end of a very nice little walkway with coconut trees on both sides. The shack was about half full of coconuts, and coming in at night presented quite a challenge to keep from slipping all over the floor.

I met Leny's (ex-VQ8CB; now 5Z4GT) old friend Pi-Po, the operator of the WX station. Pi-Po was a wonderful companion and everything I asked him to do was done with a smile. He had been there for 20 years or so. He took me over to Leny's old house, and Leny's operating table was still there. I actually saw where the key had been screwed down. His house was empty and looked as if it had been ever since Leny and his XYL, Lillette, had left some years earlier. Pi-Po told me Leny had taught him his code and what knowledge he had of radio. Leny did a good job, too, because Pi-Po was a very good operator and not too bad a technician. Pi-Po made my stay on VQ8C very pleasant.

We met the owner of the island for a long chat the first night there. His hobby was underwater photography. He showed us his home-made waterproof camera holder, with all adjustments protruding through waterproof holes so he could make all necessary adjustments while underwater. Then he showed us lots of underwater movies and a batch of color slides he had made of the waters around the Chagoes. His camera work would have delighted even Hollywood. We talked and drank tea most of the time. Some of the fellows were drinking something a bit stronger. There were no Cokes there, so I suffered in silence! They had a kerosene-burning ice box so there was ice. The water was rather salty, since the wells are not far from the ocean, though they also had rain water from the roof tops which was better. All the islands in the Indian Ocean use rain water. On Aldabra it's directed to a sort of little swimming pool, and occasionally they find a dead rat in the pool! Makes drinking this water a little rough on you! Well, you gotta have water, you know! I understand the manager of the Chagoes has left now and I guess is back in Mauritius. I bet Pi-Po is still there, though, since he just looked like a fellow who would never leave.

When I fired up at /VQ8C all the gang were there QRX for me. On almost every QSO I was told, "Gus, you are a new one." It seemed as if all the QSO's that Leny had had when he was there, year after year, had been wiped from everyone's log. There was every chance in the world for the VQ8 authorities to stop me while I was there because there is a twice-per-day schedule with the WX station at Mauritius. A message to me would have been delivered minutes after it was sent because I saw Pi-Po ten times each day and our shacks were not over 200 feet apart. I don't think anyone in VQ8 wanted to get me any messages! Before I left VQ9 I was told by them to be on that boat and not miss my chance of going to VQ8C. Everyone knew the only reason I would go to VQ8C was to operate a ham station from the island. One of these

days someone will yet hit every one of those Indian Ocean islands and wring them out dry. That is the day I will laugh my head off. Just as I have done in the AC spots with over 65,000 QSO's from them; lots more than I have ever had from my 40 years of hamming from W4BPD. But still many have asked me to return there for them! No one can work them all, even when they work everyone on the air from some spot. Two years later on it will be rare again. Look at Aldabra: two trips I was there with something over 12,000 QSO's and still many need this one.

Now let me see where I was with my story. Oh yes, I was on Chagoes and we were having supper with the island manager, who had two real nice looking "maids" for his own personal use. The supper was a real feast: fish cooked about five different ways, coconut meat prepared a number of ways, turtle meat, and items brought ashore from the ship. We got a radio message the next day from Solomon Island that a rainstorm that night had dumped over 15 inches of rain there in 10 hours. Now that's a rain for you! I asked why most of the coconut trees on the Chagoes were so straight, and they explained that the Chagoes were out of the cyclone belt and their prevailing winds were variable, so the trees had no chance to get that permanent lean like on all the other islands I had seen.

I visited their copra works and saw more doggoned coconuts than I thought there were in the world. They have very large concrete rooms with no roof overhead, just a sliding roof that runs on old railroad tracks. They slide the roof back and forth every few hours keeping the temperature just right to cure the coconut meat into copra. They told me that copra production on the Chagoes was the world's highest for the amount of land and number of workers used in its production. They say their copra is the world's best since it's under a sort of "quality control."

The island manager was telling me about something that happened on the island a few months before we arrived. One of the copra workers came running to the manager's house one day saying he had some "visitors" up on the north end of the island. The manager with a few of his workers went up to investigate. A large black ship, with no flag or markings, was anchored a considerable distance out in the sea. He estimated it to be about 350 ft. long. There were about a dozen "visitors" walking all around the northern part of the island with machine guns! They said they were studying bird life!! The manager asked them if they had any documents that indicated they were invited to come ashore. They acted surprised that anything like this was necessary, and told him they would be leaving sometime that afternoon. The big black ship was gone the next day. I have my own idea as to who it was and what they were doing. You know the Chagoes are in a very FB spot for emergency aircraft landings, and take-off's. Maybe some day someone will put an airfield there. Then it would be real easy to get to VQ8C instead of a 10-day sail from VQ9 land.

One day I was invited to go out sharking. The boat was about 55 to 60 feet long and 12 feet wide, its hold being about 15 feet deep. Only three other people went along. We went in among a number of small islands until we found the sharks. Let me tell you there were sharks there; I mean by the hundreds or maybe even thousands. Two lines of ¼ inch steel stranded wire with only one hook, about five inches long and baited with a 1-pound piece of fish, were tossed overboard. The moment it hit the water, bango, a 12-foot shark grabbed the hook and the fun started. The two fellows with their poles brought him up, lifted him into the boat—a real he-man job, this—and threw him down into the hold of the ship. The other fellow in the hold had a two-edged ax, and he chopped right into the brains of the shark. Blood flew all over him and the inside of the hold, the shark quit flapping and the lines with that big hook were again cast over the side of the boat—this time without any bait on the hook. Bango! Another shark grabbed that bare hook. Up he came and over in the hold he went. The fellow with that double bladed ax swung into the fish's brain and blood flew. This kept up for four or five hours, until the boat was full of sharks. They caught 253 sharks in that time, weighing about 5 tons. These fish are brought ashore, cleaned, dried and salted down and then shipped on to Africa where they are sold to the natives. The natives, I was told, usually eat this dried meat uncooked. I guess it's sort of like dried herring that I have seen people eat even over here.

There is always something going on on these islands. If it's not one thing it's something else. There is that stuff they get from coconut trees. It's a sort of white, milky fluid, and when it sits a few days they say it has the kick of a mule. I have yet to go anyplace where strong drinks cannot be found. They always find something to drink, you can be sure of that. I wish this were true of Coca Cola, hi, hi.

. . . Gus

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Convert Your AM Transmitter To FM

Get in on all the activity on VHF wideband FM.

Have you listened to two meters in the past few months? If you have, you've probably heard two meter repeater stations on the air. Here in Houston we have three such stations. One is on the Air Force MARS frequency and two are in the ham band. They work very well and are very popular. Repeaters are usually designed for FM service, and these are no exceptions.

I had been on two meter AM for a long time but I didn't have any FM gear. I wanted to get on FM so that I could use the repeaters but I still wanted to be able to transmit AM. I tried a Varicap (variable capacitance diode, or varactor) across the crystal, but it didn't give enough deviation to provide the sweep I needed at two meters—12 to 15 kHz. My AM transmitter uses 8 MHz crystals and multiplies 18 times to reach the two meter band. It uses a Colpitts oscillator. After a bit of work, I built the adapter shown in **Fig. 1.** It converts the transmitter so that the oscillator is followed by a phase modulator driven by phase-corrected audio. This phase modulation is equivalent to frequency modulation after it's passed through a number of class C stages in the transmitter, and, in fact, this is the FM system used in most commercial FM gear.

The adapter can be plugged into any transmitter with a VFO jack, or into any transmitter by converting it as shown in **Fig. 4.** To disable the AM portion of your rig, all you have to do is to use a shorted microphone plug. If your transmitter has push-to-talk you can run a wire from the PTT terminals to the

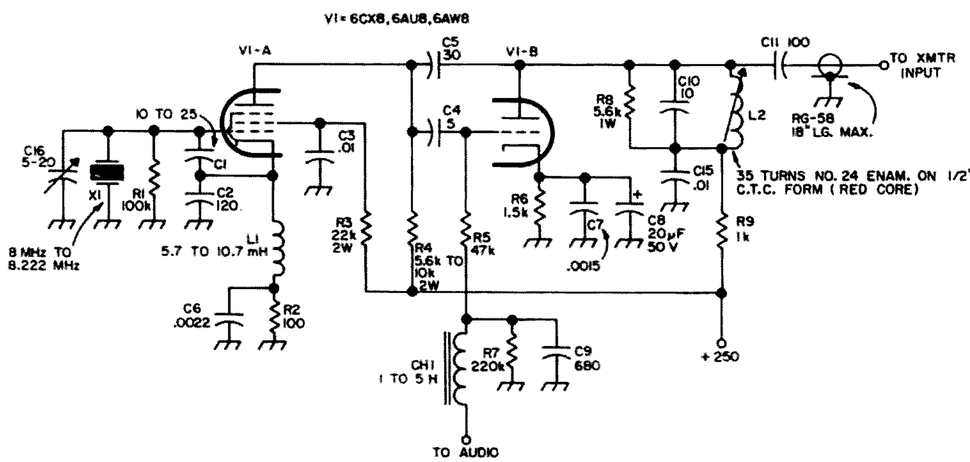

Fig. 1. FM phase modulator for two meters.

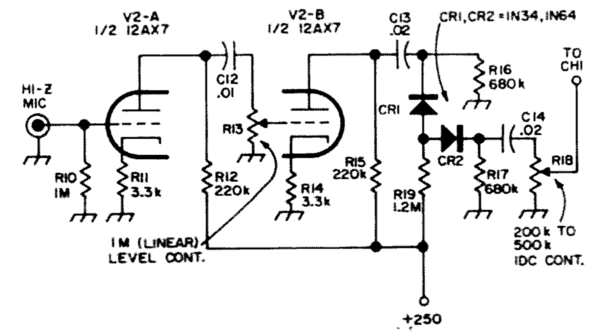

Fig. 2. Tube-type audio for FM adapter.

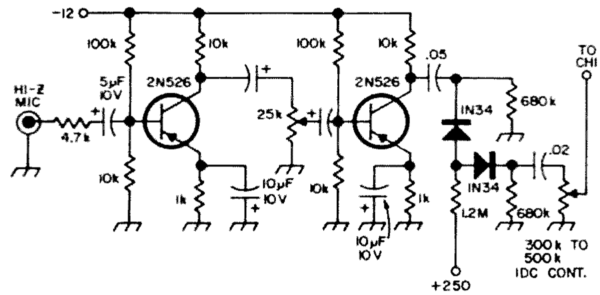

Fig. 3. Transistor audio for FM adapter.

new microphone input on the FM adapter.

The FM adapter can be built on a small chassis or in your transmitter. The wiring is straightforward. Normal rf wiring practices should be followed. None of the values are critical so 10% components are fine.

Fig. 2 shows a tube-type audio system for the modulator and **Fig. 3** an all-transistor audio amplifier. Both include clipping.

Tune up is very simple. Simply connect the adapter, plug in a crystal and turn it on. Then tune L2 for maximum negative output, around 15 volts.

To use your rig in the AM mode after you have modified it for FM, all you have to do is disable the FM audio by shorting out the audio input. Then attach the mike to the regular AM input and you're ready to go.

. . . WA5CJG

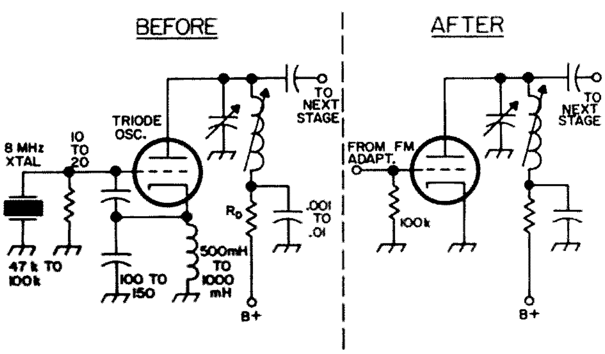

Fig. 4. Modifications to crystal oscillator stage for use with FM adapter.

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Good Hand Sending

Some reflections and suggestions

When the writer started with landline Morse in 1917 and amateur radio three years later, the use of semi-automatic keys—bugs—was not widespread, and some real "copper plate" hand sending was being produced in both codes, Morse and Continental. While Morse has nearly died out on landline, CW radio transmission is still very much alive, but really first class hand sending seems scarce. This article is written in the hope that it will interest and help some amateurs in better performance with the hand key.

As with any manual art, if keying mistakes are unwittingly repeated long enough they will become habits and be hard to stop. The novice should, if possible, practice sending in the hearing of someone able—and willing—to offer constructive criticism. Failing that, do not practice sending until you can receive well enough to evaluate your own sending. This is a hard thing to do, and experienced hams can assist the novice greatly, both in club work and on the air.

The key should be securely fastened to the table in line with the forearm, in a similar position in relation to the body as the writing pad, or somewhat to the right of it. As an alternative the key can be fastened to one end of a board fitted with rubber feet, about six inches wide and long enough to accommodate the elbow.

There is a direct relation between key sending and handwriting. Many of the oldtime key experts also produced "copper plate" writing, and the "glass arm" affliction that no doubt spurred the development of the bug is similar to writer's cramp.

A free and easy style of holding and manipulating the key is akin to the exercises that were used in such training as the MacLean system of handwriting. The best method for good character formation without tiring is mainly forearm and wrist action rather than wrist and fingers, with the grip on the key being loose enough to prevent tenseness. The elbow will roll or "ball" on the table top without leaving it, and the forearm will move up and down considerably further than the key lever. There are two reasons for this "overthrow": one, the key-top movement is unnaturally short for the human arm, and continued sending without the overthrow would soon produce tenseness and strain. The other reason has to do with key design. A string of dots should measure about 50% of closed circuit current on a meter, that is the dots be the same length in milliseconds as the spaces between them. In a bug one of the dot contacts is flexibly mounted, so that with proper adjustment there is "follow" each time the contacts close, which provides the proper dot length. On the standard hand key with its rigid contacts, if the arm does not continue downward or pause after the contacts close, the dots will be too short or "light." A pause is not practicable for rhythmic hand sending, so the overthrow is the only solution.

With key travel and spring tension suited to the individual, and with correct grip and arm action, it should be possible to send continuous dots at a natural speed for several seconds without tiring, and with no discernible change in pace or "percent make." This is a good practice exercise.

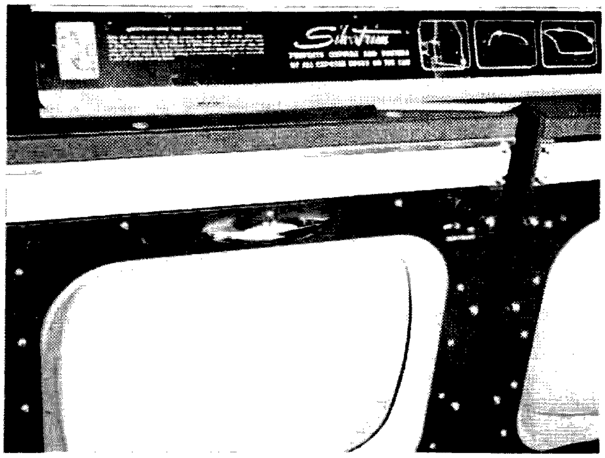
Until proficiency is attained, don't be afraid to make the spaces between words extra long—this will help the receiver to separate the words in case there is any hesitation *inside* the words.

Improper spacing inside *letters* is a more serious error, and is most common on letters where dots and dashes are intermixed. In these more difficult letters one aid for the beginner is to make the dashes extra long. In the letter *A* for instance, if there is any pause between the dot and the dash it can be received as ET, but if the novice sender thinks and sends a dot and *immediately closes the key*, it can only be received as A even if the final key opening is delayed. Build up other letters from this beginning; *R* is formed by immediately making a dot after the dash in *A* is terminated; *C* is produced if the key is closed and *R* formed immediately it is opened. To make *U* or *V*, send the two or three dots and close the key; *D* or *B* are two or three dots sent from a closed key, and so on.

Your keying may not *seem* to be as imperishable as your writing, but when you are on the air who knows how many people are listening—and who knows, maybe somebody is *recording* it!

Good sending—and good C.W. QSO's!

. . . VE7CT



Automotive Trim Brightens Construction Projects

Chrome finished plastic trim strip, available in automotive supply stores, fills many construction needs. Economical and easy to work, this material really dresses up the rough edges on a project. This brilliant trim is made of moderately flexible plastic, 7/16-inch wide and formed in a closed "U" shape to fit over panel edges up to 1/8-inch thick. The inside of the channel is coated with pressure sensitive adhesive to hold the strip in place after installation.

Applications of the trim strip include framing of panel openings. In this use, work is really speeded up since only a rough-cut, reasonably square hole is required. The strip completely covers the rough edges. Installation is a snap since the product may be easily cut to exact size using a sharp knife, razor blade or diagonal pliers.

The photograph shows a typical use for the strip. How many times have you installed rack mounted equipment and found that standard panels failed to quite fill the available rack space? The trim strip provides a simple, low cost and highly decorative answer. Slip a 19-inch length of the trim over the edge of the offending panel and cut the back side of the strip as required to provide clearance for the rack mounting rails. Install the panel and position the strip to fill that unsightly gap.

The product shown in the photograph is "Silvatrim" manufactured by Glass Laboratories, Inc. of Brooklyn, New York. Two 33-inch lengths of the trim, mounted on a display card, sell for around a dollar.

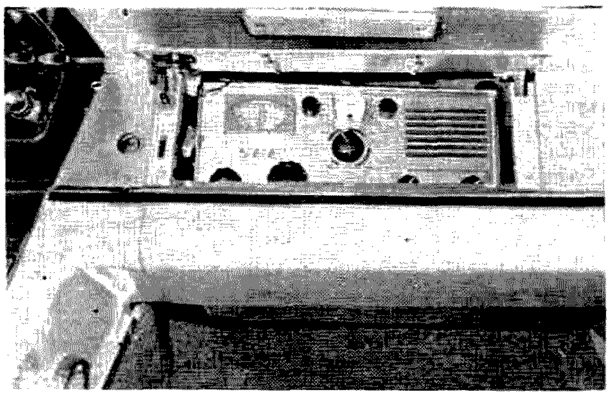
. . . Roy Pafenburg W4WKM

Now You See It; Now You Don't

The addition of a mobile rig is not always the happy event that an addition to the family should be. The XYL may not be tolerant of a husband who seems to prefer to talk to strangers rather than to the wife while driving on the vacation. Even if a ham, who enjoys talking on the rig . . . the wife's enthusiasm dwindles the second she snags her nylons or draws blood on the sharp corner of the rig under the dash.

Every ham wishes his car had come equipped with a cutout in the dash designed for his rig. The dash and glove-compartment installations of the past were limited to low power, often home-brew rigs for one VHF band. With the coming of SSB transceivers, mobile operation has become a reliable means of communication with high power in small packages.

My mobile rigs, until recently, were conventionally mounted under the dash with the



It's easy to get at when the glove compartment door is open, but invisible when the door is closed.

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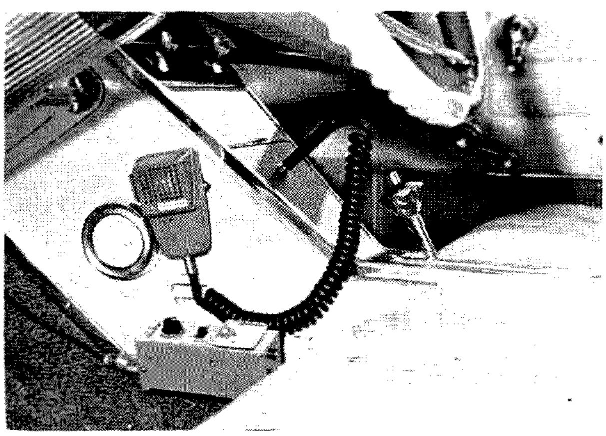
expected side-effects on the XYL. The "out of sight, out of mind" solution to the XYL problem came as a result of a middle-age weakness which caused me to close a deal on a luxury automobile without thinking about where to put the ham rig. The type of car purchased is characterized by the manufacturers as a sporty personal automobile. . . . to avoid offending the "true" sports car owners. This Detroit specimen is easily recognized by the console or divider strip which separates the front seat passengers; and incidentally occupies all of the space normally available for the rig.

My wife was naturally pleased with the deluxe features of the car as she remarked, "Looks like there is no room for your ham rig in this one." The grin faded from my face as I realized she might be right. Soon I had the gear salvaged from my trade-in piled along side the new car, and commenced to



Mike and SWR bridge are installed neatly by the driver in the console.

measure the rig and examine the car for any bit of space.

Fortunately, some months before I had been seduced by the glowing reports of the receiving ability of the SBE series of transistorized transceivers. With the arrival of the SB-34, I had picked up a bargain in the SB-33, which is the same size, but lacks some styling and features of the 34. These rigs measure only 11¼″ wide, 10″ deep, and 5″ high, yet offer high performance in the 80, 40, 20, and 15 meter bands in SSB mode. The installation shown in the photographs may suggest solutions to other hams who have the same or competitive rigs approaching or bettering this small package size.

The glove compartment when opened revealed a dinky and shallow space that was not at all suitable for my rig . . . but wait, the opening itself looked large enough. A few minutes with the tape measure confirmed that the opening in the glove-compartment was larger than the width and height of the SBE. Close examination revealed that the compartment was a basket-like affair held by screws to the frame of the door opening in the dash. A minute with the screwdriver left a glorious expanse of space extending to the firewall with only a few flexible cables that might be in the way . . . heater controls etc. Sliding the rig in from behind proved a cinch and confirmed a perfect fit with no problems in closing the door of the glove-compartment.

Since the SBE has a self-contained AC supply tailored for 117 volt operation, I deemed it desirable to design the mounting for easy removal to permit portable operation. In my car body style (Buick Riviera 1963-65), the lower metal structure of the dash housing forms a natural shelf. It only required a small wooden platform shaped to tilt the rig slightly and raise it about two inches to provide a solid mounting. The platform is retained in place by wedging it under the rig, forcing the transceiver to press against the top of the dash from underneath. A similar platform in another installation might require ventilation holes, although none were used with the SBE.

Now with the rig mounted, and the power cables running through grommets in the firewall, I found I could close the dash compartment door and the rig disappeared. It suddenly became very desirable to complete the installation while retaining this concealment philosophy. The mike cord was the first fly-in-the-ointment as plugging in the PL-068 kept the door from closing . . . also the mike was almost out of reach from the driving position. A right angle plug by Switchcraft

is made in the PL-068 type, and is a must for SBE or Collins rigs of recent vintage. This right-angle plug wired to a short piece of shielded twin lead allowed me to make an extension to a new jack located in the center of the console. This allows the mike to be easily in reach of the driver and a hang-up clip can be mounted conveniently on the driver's side.

To complete the installation, a MARS SWR-bridge was attached with L-brackets to the side of the console using the same screws which hold the chrome trim. In addition to making antenna adjustments easy and repeating the modulation indications where the driver can see them, the SWR-bridge also makes a convenient terminal block from the heavy RG-8 antenna lead to the smaller RG-58 cable running under the dash to the rig. The antenna and power supply are mounted conventionally so need not be discussed. The installation pictured has been in daily use for almost one year without any trouble. The XYL is happy, and the OM has the additional satisfaction of knowing that even with his ham plates on the car . . . potential thieves see no rig when peering in the window.

. . . WA6DLI

(Continued from page 4)

on for many minutes calling and never stand by to see if the DX station is coming back or not. This may sound idiotic, but I've heard it happen far too many times to ignore it.

Even so, I tried out the transceive system, but with firm control of the situation and rules that were inflexible and fair. I found that this worked wonders even when my signals were very weak. I countered the tendency to give long calls by working fast break-in and stating that I wanted to get one call and one call only, then we would see if I had gotten the call. Long winded ops soon found that they were hearing only the end of my transmissions and they pruned their calls.

Fifty stations breaking in all at once seldom resulted in any one standing out. So I broke the pileup into call areas and then, if this didn't reduce the piles enough to let one or two stand out, into prefixes, one through zero. Prefixes are tricky. If I asked for W2's, I got K2's, WA2's, WB2's and everything all together. So I learned to start with WB2's . . . no W2 could possibly break in when I ask for WB2. Then WA2's, then K2's, and then, finally W2's. This rarely failed to work out. Once everyone knew that I was inflexibly working my way through the call areas the system was self policing and any out of turn breakers were dealt with by angry waiters.

This system made it so I was able to work quite a few mobiles and low powered stations that had seldom been able to contact DX before. I worked each prefix right down to the S-1 signals before going to the next prefix. One chap complained that he had had to wait fifteen minutes to contact me. That's really pretty good. A complete round seldom took more than twenty minutes, during which time I would work about 75 stations. About every five minutes I'd give QSL information.

The prefix system works quite well for Europe too and I was able to polish off long strings of DL's, DJ's, SM's, and G's this way. When the U.S. is coming through predominantly I find that if I stand by for "any other two's" after mining the WB2, WA2, K2 and W2, that in will come the VE2's, the VP2's, the YN2's, and such . . . even ZL2's and VK2's queue up this way, and the lack of QRM on the channel allows them to get their reports in turn, though they may be just barely audible.

Giving rare DX contacts is just like a contest. You have to exchange call signs and signal reports and get on with it. Speaking of contests, I had a speaking engagement at the Manchester (NH) radio club at their annual banquet right in the middle of the World Wide DX Contest so I decided not to enter it seriously. I did go in it working one station from each country I heard and I was up to 85 countries during the first day of the contest, including a full night's sleep. I'm sure I could have broken a hundred if I'd kept at it.

Area for experiment

Those of us interested in DXing have been wondering for a long time now about the advantages of the quad vs the yagi antenna. An examination of the antennas used by outstanding DXers has not been conclusive since both types of antennas are generally well represented in the DX fraternity. It is interesting that almost all of the DX antennas are either yagis or quads.

QST had an article by W4RBZ comparing the two at his QTH in their October issue. We don't get all the good articles, only most of them. He went on at length on his comparison and the result was that he found the four element yagi and the four element quad to be about the same much of the time, but the quad to be advantageous by 2-3 dB where a lower angle of radiation would help.

This angle of radiation business needs more investigation. A few fellows are running their beams up and down the tower to get the best angle. In my experience different types of beams give us different angles of radiation. I tried the Twin-Three (twin-triplex) back when it was first introduced in 1948 and found it a real winner. This is an 8JK type antenna made up of two threewire dipoles spaced one sixth wave apart, fed out of phase. The result is a bi-directional beam with an exceptionally low angle of radiation. It was my experience that I almost invariably got the report that mine was the first signal through from the States and then, as the other signals began to come up I would get calls from further on, again reporting only my signal coming through.

When the sunspots dropped down, the degree of ionization went below that which would permit my low angle signals to propagate and the antenna became virtually useless.

The sunspots are climbing rapidly now and should be at a peak in the next couple years. I'll be very interested in reports on low angle radiation antennas and any experimental work on varying the angle of radiation of arrays. The three element yagi I'm using now gets out just fine, but the propagation is quite normal and my signal comes in and goes out along with all the others.

Any takers? . . . Wayne

(Continued from page 6)

Even if they do try to charge taxes on some of the income, it will take a lot of figuring to decide how and on what. Most non-profit groups can rearrange their books in perfectly legitimate ways to show profits or losses on individual activities they engage in.

Of course, as I mentioned above, freedom from income taxes is only part of the bounty non-profit groups garner. They also pay very low postage on their bulk mailings. Organizations judged tax-free by the IRS are eligible for special mail rates from the Post Office. These low rates can amount to huge savings on the mail involved.

Most magazines in this country are mailed second class. For this mail, postage is paid by weight. For taxpaying magazines, the Post Office figures what percent of each issue is advertising and what percent is not. This non-advertising part is usually called editorial matter. The magazines are charged 2.8¢ per pound for editorial matter and between 4.2 and 14¢ per pound for advertising depending on the zone to which the magazines are mailed. The average for 73 is 9¢ per pound, and since each 73 weighs half a pound, average postage on it is 4.5¢. That's hardly an unreasonable fee in spite of the poor service we receive. Apparently the PO isn't losing money on regular magazine delivery, though.

Against the 9¢ per pound (a fair approximation) paid by tax-paying magazines, tax-exempt magazines pay 1.8¢ per pound. Period. No extra charges for advertising, no zonal breakdown—and one-fifth the cost. This and other postal subsidies to non-profit organizations cost regular businesses and other postal patrons about $300,000,00 per year.

It's interesting to compare our bill for mailing 73 with what it would be if we received the government subsidy given non-profit organizations. We pay about $15,000 a year to mail 73. If we received the low rate for non-profit groups, the cost would be only $3000. We're not so big that the $12,000 difference is unimportant to us—or you, since, of course, that amount could be spent on more and better articles, higher pay for authors, a larger staff so that we could answer more questions from readers, and so forth. Yet we know that we're paying a very reasonable amount for delivery of 73.

The other type of bulk mail used by magazines is third class. It's used for promotions, renewal notices and so forth. Tax-paying businesses such as 73 are charged about 2.8¢ per item mailed this way. Tax-exempt magazines pay only 1.3¢ apiece. Again taking 73 as an example, we mail about 300,000 pieces of third class mail each year, so the difference between the two rates is substantial. Here again, the Post Office loses money carrying mail for tax-free organizations. The total figure is $300 million a year.

To most people who know about this situation, it seems unfair. Are the articles and ads carried by the non-profit magazines so different from those in tax-paying periodicals? Why should one group have to pay five times as much to carry an ad to a reader as another? The Post Office and Congress have discussed the situation at length, but have done nothing about it so far. There are very influential people on the boards of most of these non-profit organizations and they naturally do what they can to prevent losing the subsidies for their groups.

The Postmaster General appointed a committee of distinguished citizens to study the problem of postal rates and, among other things, they recommended that the Post Office

> Seek legislation to discontinue all preferential rates which now acount for nearly $300 million of tax-supported public service costs. If subsidies are justified, they should be paid directly from Treasury funds rather than indirectly via postal rates.
>
> Report of the Advisory Panel on Postal Rates
>
> May, 1965, Govt. Printing Office

As the Post Office and Congress study mail rates, the matter will come up again. Perhaps Congress will eliminate these special subsidies which cost you and me $300 million a year. If not, take comfort in one thought: we'll undoubtedly be helping some non-profit, non-lobbying organization do good—as well as paying a government subsidy to the Chamber of Commerce so that it can compete with McGraw-Hill.

° ° °

And what does the above discussion have to do with amateur radio? Not too much. But it does concern amateur radio publishing and many of you are interested in this business. 73, Inc., which publishes 73, and Cowan Publishing Co., which publishes CQ, are tax-paying organizations. The American Radio Relay League, which publishes QST, is classified a non-profit organization and is therefore eligible for the special treatment mentioned above. The ARRL is not doing anything illegal as the laws and court decisions now stand and would obviously be incompetent businessmen if they didn't take advantage of their favored treatment. Though the ARRL's annual report is quite detailed, it is almost impossible to make a satisfactory estimate from the report of what

SOME ARTICLES TO COME IN 73

PAØVDZ—432 MHz TV Converter
W7OE—Novice Series
K3OJK—Phase-Locked Microwave Oscillator
K6JFP—Solid-State RTTY Indicator
WB6CHQ—Solid-State Product Detector
K6YKH—SSB Proof of Performance
W6BLZ—All-Band SSB Receiver
W1DCG—CW Audio Filter
K8DOC—40 Meter Vertical
W3ZP—Aero Mobile
Elkhorne—Edison: The Fabulous Drone
WA6NIL—Charging Dry Batteries
W1DCG—Buried Antennas
K6GKX—The TS-34 Scope
W6JTT—APA-38 Panadaptor
VE1TG—Beginner's 10 Meter Beam
W3WPV—160 Meter Flattop
VE1TG—The Really Rugged Rotator
VE1ADH—Assault on FP8
W6DDB—Novice Data
WB2PTU—813 Linear
WA2APT—Miniquad
W1DCG—Minibridge
K1CLL—150 Watts on Two
W1JJL—UHF Dippers
WB2GYS—Video Camera Tubes
W6BLZ—The Ancient Marriner
W6MUR—The QRZ Machine
K6ZGQ—A Little About Noise
W7CSD—6KG6 Linear
K8ERV—Equalizing AFSK Tones
VK9TG—Hamming, VK9-Style
W2DXH—Voltage Calibrator
W5SJN—FET Six Meter Converter
W6AYZ—RTTY Encoder and Decoder
W6GXN—FET S-Meter
W6OSA—Improved UHF Multipliers
K6ZCE—ID Generator
W7CSD—Vacation Antennas
KØOLG—Silicon Diode Tester
VE1TG—Broad-Band 80-Meter Vertical
Cameron—7 Element 20-Meter Beam

raction of the ARRL's annual expenses is deoted to "non-profit" activities (for which they re considering charging non-members) and what part is devoted to publishing. It is obious that the lion's share goes to publishing, nd an unbiased observer (obviously not me) ight think that their publishing activities look urprisingly like the activities of Cowan Publishing, Editors and Engineers, Howard Sams o., Radio Publishing—and 73.

Other reference: "Publishing's tax freeloaders," by Jimm Galligan in Printer's Ink, August 12, 1966.

Fundamental abbreviations

A number of people who have objected to the term *hertz* seem to feel that *cycles per second* is more "basic" or "natural" than hertz. hat's probably right, but there's more to the story than that. In the first place, did you ever otice that there's something basically different between cycles per second and most of the easurements we use such as volt or foot or uart? Well, there is. Cycles per second (or hertz) is not a measurement at all; it's a count of occurrences in a certain time period. Mathmatically, the name cycles is superfluous. e'd be more correct in saying 1000 per secnd than 1000 cycles—but are better off to just say 1000 cycles per second or 1000 hertz. usicians often say vibrations per second intead of cycles per second; the terms mean the ame thing.

But also don't forget that all electrical units an be stated in terms of four basic quantities: length (meter), mass (kilogram), time (second), and an electrical unit. Almost any electrical unit can be used, but for our purposes, the coulomb seems most convenient. The coulomb is a quantity of electricity, 6.28×10^{18} electrons. If we write our common units in terms of the basic units, we find that an ampere is a coulomb per second (coulomb/second) and the other units are:

$$\text{watt} = \frac{\text{kilogram-meter-meter}}{\text{second-second-second}}$$

$$\text{or } \frac{\text{kilogram-meter}^2}{\text{second}^3}$$

$$\text{volt} = \frac{\text{kilogram-meter}^2}{\text{coulomb-second}^2}$$

$$\text{ohm} = \frac{\text{kilogram-meter}^2}{\text{coulomb}^2\text{-second}}$$

$$\text{farad} = \frac{\text{coulomb-second}^2}{\text{kilogram-meter}^2}$$

$$\text{henry} = \frac{\text{kilogram-meter}^2}{\text{coulomb}^2}$$

$$\text{hertz} = \frac{1}{\text{second}}$$

All of the above is rather technical and perhaps even pedantic in a ham magazine. Nevertheless, I suspect that those who say they prefer cycles per second to hertz because it's more basic aren't anxious to adopt any of the more basic equivalents to other common units.

. . . Paul

Letters

New Propagation Charts

Dear 73:

The new enlarged propagation chart is a tremendous improvement over the tiny old one. The article by John Nelson of the future of the ten-meter band in the October issue is excellent, too. However, my 73 keeps arriving so late that part of the chart is unusable. I hope that you'll try to get the magazines out earlier.

M. L. Peterson W2FMX
Waterville, N.Y.

Dear 73:

I do not like the propagation charts. The old one I could Xerox, delete the East and West Coast sections and have a convenient reference at hand, one on the operating table and one in my desk at work. The new one does not give any more info than the old one, but takes two pages instead of half a page. And it's in red, which doesn't Xerox. Also, it is now necessary to look from the chart to the legend. One vote for the old chart.

Harlan Bercovici KØBHT
St. Louis, Missouri

Rotten 73

Dear 73:

Back in '62 when I first started buying 73 on the newsstand I used to count the days till the new issue would arrive, then rush home clutching the precious copy in my hand in anticipation of the swell construction and technical articles that were between the covers. Now that you've wrested a subscription from me, what's happened? I don't see quite as many construction articles on down-to-earth stuff.

Just comparing the last issue, the article, "A Pox on Your Junk Box," belongs in the junk box—way down on the bottom.

And nothing against Gus, but 15 issues already? And the end is still not in sight! I have enough experiences of my own, let alone reading about someone else's.

And the coaxial accessory handbook—fine for one issue but let's not drag it out. Swell information, but any ham who doesn't already know a third of it shouldn't be classed a ham in my opinion. A good book on the subject would supply the other two-thirds, which, by the way, I would purchase if I had a need of it at the present time.

So I'm taking a wait-and-see attitude for another year and renewing 73. Let's stop cluttering up and return to the swell magazine you used to put out.

Francis Brna K3KKG
Washington, Pa.

Dear 73:

Anyone would be out of his mind if he didn't renew his subscription to 73.

Syd Tymeson W3FL
Takoma Park, Md.

Micro-Ultimatic Keyer

Dear Paul

The Micro-Ultimatic Keyer article was one of the most timely articles in quite a while. Finding no fault with its operation, I have to nit-pick, and bring up the fact that the symbol shown for the 914 gate is in error, as is the terminology used for it.

The gate is, in fact, a NOR gate as mentioned in a footnote, but is not a NAND gate without qualification. It is a *negative* NAND gate. The difference is significant as the truth table for the NAND is exactly opposite from the one shown in the article!

The symbol for a NOR gate has a concave back, rather than a flat back. The circle is still on the output side. The symbol for the negative NAND is sometimes used interchangeably in the industry since it has the same truth table. This symbol has a flat back like the NAND gate, but has a circle on each of the inputs and none on the output. Incidentally, the circles represent inverters. These are the MIL-SPEC symbols, and are used by a majority of the manufacturers, including Fairchild.

E. Jorgensen K1DCK
Electronic Associates Inc.
Dedham, Mass.

AM on Twenty?

Dear 73:

After reading WA5FRL's letter in the October issue, page 93, "AM on Twenty? Bah," I think something should be said in defense of AM. WA5FRL says "those who choose to work AM as a matter of personal preference can do so on other bands." Well, apparently he hasn't been listening to those other bands. The SSB interference is just as bad on 40 and 80 as it is on 20. The gentlemen's agreement worked out fine until the newer SSB operators broke it! The FCC says both AM and SSB can operate from 14.20 MHz to 14.35 MHz. WA5FRL apparently wants all AM on 20 meters outlawed to satisfy his own selfish needs and wants. The amateur bands are for everyone—not just for one person or one small group of people. I will continue to operate on 20 meters AM from 14.2 to 14.25 MHz as per the genlemen's agreement.

Ronald Zurawski WA8FVD
Menominee, Michigan

Two Meter Repeater

Dear 73:

I read with considerable interest the article on a "Two Meter Repeater" in the September 1966 issue of 73 Magazine. I noted, however, several technical points that bear consideration when utilizing this system in the amateur bands. I am not familiar with the regulations or technical restrictions imposed by the Air Force MARS program, so I will restrict my comments to application of this system within the limits of the amateur bands where it falls within FCC jurisdiction.

First and foremost, the method of keying the transmitter is not a fail-safe system. In the event of failure of the keying tube V314, the discriminator V309, the noise amplifier V310, or the noise rectifier V311, the keying relay will drop out, permanently keying the transmitter on.

Second, no mention is made of a timer in the transmitter keying circuit to limit the on-the-air time. In the event of a keying relay circuit failure or a continuous carrier of any form on the input frequency, the repeater would he on the air continuously, thus rendering the frequency useless.

Third, no mention is made of controlling the repeater from some other point so that it can be deactivated in case of a failure as mentioned previously, or in case of misuse. In such event, someone would have to make a trip up the tower to turn the thing off! This comment is made on the assumption that the repeater is unattended.

In addition to these comments, I might mention that the majority of FM operation around the nation is vertically polarized, and this is recommended if operation on 146.940 MHz or 52.525 MHz, etc., is contemplated. Also, you might obtain an improvement in audio quality by taking the audio from the receiver directly from the output of the discriminator, at the discriminator test jack, thru a cathode follower.

When used in the amateur bands, some form of logging the repeater transmitter must be provided, be it a tape recorder, pen and ink strip chart time recorder, or what have you. Also, automatic identification is convenient so as to alleviate the necessity of stations operating thru the repeater from identifying the repeater as well as their own stations.

The transmit frequency suck-out crystal is an interesting feature, that we will keep in mind for our repeater.

I might make a few suggestions to alleviate some of the problems pointed out.

First, I recommend a keying circuit similar to that used in General Electric's Progress Line Mobile Telephone System "busy-circuit" which uses a single 12AT7. It samples both noise output from the discriminator and limiter grid voltage. In order for it to key, two conditions must reduce, or "quiet," and the limiter grid voltage must increase, both conditions occurring only with the presence of a carrier at the input of the receiver. In the event of failure of any tube in the receiver, the relay will not key, thus providing a fail-safe keying system.

Second, a three- or ten-minute timer is recommended in the transmitter keying line to prevent the transmitter from locking on the air continuously in the event a continuous carrier is received.

The timer and cathode follower options are available on G.E. remote control panels, which can be obtained from sources similar to the receiving and transmitting gear.

Third, some method of controlling the repeater must be rovided in case of misuse or malfunction. Used 450 MHz 'M equipment is easily available and has been used quite ffectively for remote control purposes.

These comments are offered in the hopes that you might void some of the problems we have encountered in the onstruction and *operation of* a repeater system *in* the reater Baltimore area. During the past five years we have eveloped a system including six to six, six to two, two to ix, and two to two repeaters, all using 450 MHz for re- ıote control of several sites, as well as for point-to-point inks. We use Secode tone coding equipment for primary nd secondary control. Future plans call for interconnec- ion with the greater Washington, D.C. area, and the York nd Carlisle, Pa. areas, so as to obtain continuous coverage ver the entire area.

Gary Hendrickson W3DTN
Secretary-Treasurer
Maryland FM Association, Inc.

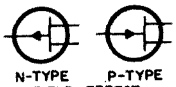
)ear 73:

A word of thanks for your good magazine and a few omments on your September issue. The two meter re- ıeater article was quite good overall, but the GE Progress ,ine 4ER25D receiver mentioned is definitely not cheap on he West Coast if it can be bought at all. It runs $50 to 125 when available. It is very easy to narrow band at cost of only a few dollars, so is still popular for com- ıercial use. Other GE and Motorola models, available at ɔwer cost, will perform better. Also, in Fig. 3, the 100-kΩ 'olume pot should be 250 kΩ and the squelch pot 15 kΩ. 'he repeater as shown will work but a much better job ould be done with the time and money invested.

James Lev K6DGX
Huntington Park, Cal.

Correction

'he symbols for the N-channel and P-channel field effect ransistors in the chart on page 75 in the September 73 are hown reversed. Here are the correct symbols:



STATEMENT OF OWNERSHIP, MANAGEMENT AND CIRCULATION
(Act of October 23, 1962: Section 4369, Title 39, United States Code)

Publisher: File two copies of this form with your postmaster

DATE OF FILING: 13, Sept. 1966 — TITLE OF PUBLICATION: 73

FREQUENCY OF ISSUE: Twelve times per year

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6. NAMES AND ADDRESSES OF PUBLISHER, EDITOR, AND MANAGING EDITOR

PUBLISHER (Name and address): Wayne Green, Peterborough, New Hampshire

EDITOR (Name and address): Paul Franson, Peterborough, New Hampshire

MANAGING EDITOR (Name and address):

7. OWNER (*If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding 1 percent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a partnership or other unincorporated firm, its name and address, as well as that of each individual must be given.*)

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Stockholder: Wayne Green	Peterborough, N.H. 03458

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E. TOTAL DISTRIBUTION (*Sum of C and D*)	45,552	49,207
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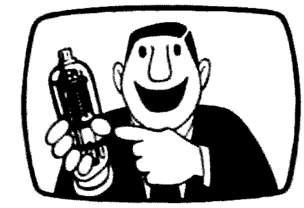
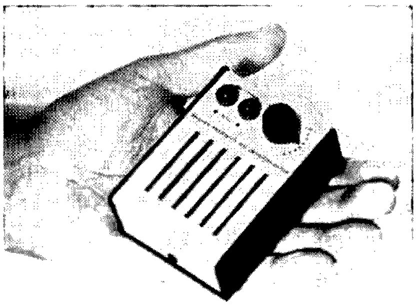


NEW PRODUCTS

Ami-Tron Toroid Cores

In addition to their famous toroid core kits, Ami-Tron is now carrying a complete line of toroidal cores in stock that fill almost any need. These cores are available in several sizes from 0.370" O.D. to 2.00" O.D. with prices that range from 45¢ to $3.00. There are three types of ferrite available which cover the frequency range of 500 kHz to 30 MHz, 10 to 90 MHz and 30 to 200 MHz. Although Ami-Tron does not supply winding data for each of these cores, it is assumed that the user can proceed empirically in the toroid design; their data sheet on these cores provides some helpful hints along these lines. For more information, write to Ami-Tron Associates, 12033 Otsego Street, North Hollywood, California 91607.



James Research Oscillator/Monitor

This new unit from James Research is a sensitive broadband rf detector which produces an audible tone signal when activated by an rf field. The detector is quite sensitive, and will respond to as little as 10 milliwatts of power from 100 kHz to 1000 MHz. It is useful for tuning up transmitters, checking oscillators and stray rf fields or as a CW monitor. In this case it will emit a clear sidetone whenever the transmitter is keyed. For use as a code practice oscillator, a key may be connected directly to the device; in some cases the leads going to the key may be used to detect rf from the transmitter. Other features of this unit are built in tone control and speaker, small size, low battery drain and 90 day guarantee. $12.95 from James Research Company, 11 Schermerhorn Street, Brooklyn Heights, New York 11201.

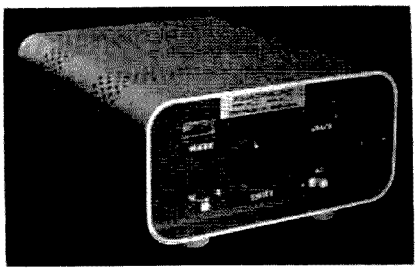
Lafayette HA-700 Amateur Communication Receiver

Lafayette's new HA-700 communications ɜceiver features 6 tube superhetrodyne cir- uitry with two mechanical filters in the *if* ɔr superior signal selectivity. The sensitive rf tage incorporates a front panel controlled ntenna trimmer and sensitivity of 1μV for dB signal to noise ratio. Frequency stability ; maintained by continuous filament voltage n the critical oscillator and mixer stages.)ther important features of this new receiver re built-in BFO, variable BFO tone for im- roved CW reception, slide rule dial, flywheel perated tuning dials for smooth, fast tuning, nd silicon diode automatic noise limiter and ıVC circuitry for efficient noise suppression. 'requency coverage: 150-400 kHz, 550-1600 Hz, 1.6-4.0 MHz, 4.8-14.5 MHz, and 10.5- 0 MHz. Selectivity: 10 kHz at 55 dB down. 89.95 from Lafayette Radio Electronic Cor- oration, 111 Jericho Turnpike, Syosset, L.I., I.Y. 11791.

Aquadyne Radioteletype Terminal Unit

Aquadyne, Inc has just introduced a new ransistor terminal unit for the reception of adioteletype signals. Designed specifically for he radio amateur, this new converter is oused in an attractive small case and features peration from either the high impedance eadphone output or low impedance speaker utput of the receiver. A three section audio lter provides good discrimination against oise and interfering signals.

Eight transistors and six diodes are used in he circuit which includes two meters for ac- urate tuning of the received signal. A solid tate regulated power supply assures stable perations from the AC power line. Provision ; made for receiving three different radio- ɜletype signal shifts: 850 hertz, 425 hertz nd 175 hertz; this permits reception of many ·ommercial stations as well as amateurs. ;ince this converter operates the print magnet lirectly, there is no necessity for a polar relay. 'or more information, write to Aquadyne, nc., Box 175, East Falmouth, Mass. 02536.



Aquadyne RTTY Converter Kit

The new Aquadyne KTY-1 receiving converter kit utilizes five silicon transistors and four diodes in a circuit that provides the signal for driving the selector magnet of a teleprinter. The audio filter section uses 88 mH toroids and mylar capacitors for separating the mark and space signals. This converter is designed for the 850 hertz shift normally used in amateur RTTY operation, but sufficient bandpass is allowed for those signals encountered in the ham bands that don't have precisely 850 hertz shifts.

Although the audio filter circuit is pretuned, the other parts of the converter are assembled by the purchaser on a printed circuit board. When operated from the audio output of a communications receiver, this unit provides a simple converter for those interested in receiving RTTY signals with only a modest outlay of time or money. $24.95 from Aquadyne, Inc., Box 175, East Falmouth, Mass. 02536.

Motorola Semiconductors

Motorola has just announced several new semiconductors which should be of interest to amateurs. First of all, they have three new field effect transistors in plastic cases which will retail for 50¢ in large quantities. These FETs are designed for general purpose audio and switching applications. The low price of the MPF103, 104 and 105 should popularize the use of field effect transistors in input stages to audio amplifiers, low frequency crystal oscillators, VFO's and other applications where the high impedance of the FET offers considerable advantage.

The other new device from Motorola is the 2N3950, a transistor that provides a guaranteed 50 watts at 50 MHz with a minimum power gain of 8 dB. Although 2N3950 is characterized for Class C operation, it can also be operated Class A or B to meet high power ssb requirements through 76 MHz. The data sheet on this new transistor includes data measurements that describe large-signal Class C behavior of the device. These measurements are made at full operating power

and are more accurate than small signal parameters when designing high power stages. In fact, these characteristics now make it possible to design large signal rf output stages without resorting to the older cut and try methods.

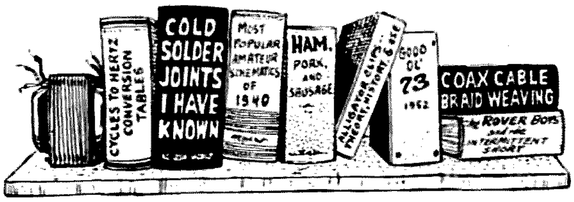
Both the 2N3950 high power rf transistor and MPF-series field effect transistors are available at Motorola distributors. For more information write to Technical Information Center, Motorola Semiconductor Products Inc., Box 955, Phoenix, Arizona 85001.

Eicocraft Solid-State Electronic Kits

Eico has just come out with a line of professional solid-state kits at popular prices. With these kits it is economically feasible for the newcomer to the electronics field and the beginner in electronics to work with professional components at modest cost. These new kits are designed, manufactured and backed up by 20 years of kit experience in ham gear, test equipment, stereo and hi-fi; only the complexity has been reduced to make kitbuilding easier, faster and less expensive. Each Eicocraft Trukit consists of solid-state circuitry, pre-drilled copper printed circuit boards, finest quality compounds and comprehensive step-by-step instructions. Among the kits presently available are the code practice oscillator, power supply, audio power amplifier, and intercom; prices vary from $2.50 to $9.95 per kit. For more information write to EICO Electronic Instrument Company, 131-01 39th Avenue, Flushing, New York 11352.

WA6FKYN RTTY Filters

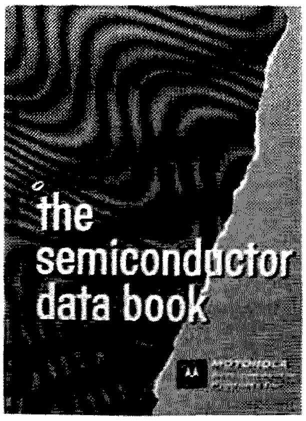
James R. Humphrey WA6FKN has just come out with some compact RTTY filters that look ideal. Each of these filters consists of an uncased 88 mH toroid coil tuned to the exact audio frequency with a high grade mylar capacitor. The use of a mylar capacitor insures frequency stability and long life. These components are mounted on a small 1¾" by 2" printed circuit board. Provisions are made on the board for the addition of a low impedance winding and/or a loading resistor. In addition, the toroid center tap is brought out to a separate pin. Each of these filters carries a money back guarantee and is available for $4.25 each; specify exact frequency with order. WA6FKN also has uncased center tapped 88 mil coils available, 5 coils for $2.50. Write to James R. Humphrey WA6FKN, P.O. Box 34, Dixon, California 95620.



NEW BOOKS

Amperex Electron Tube Catalog

Amperex Electronic Corporation has just announced the latest edition of their Condensed Electron Tube Catalog. This new catalog contains a description and basic specifications of the full line of Amperex tubes and serves as a quick reference guide for new equipment designers and replacement tube buyers. This catalog covers power tubes, subminiature tubes, entertainment and audio tubes, premium quality tubes, UHF special purpose tubes and many other special purpose vacuum tubes. A special insert in the catalog covers the basic specifications on Amperex microwave tubes and components; included on this insert are magnetrons, klystrons, disc-seal triodes and traveling wave tubes. Free copies are available by writing on your company letterhead to Amperex Electronic Corporation, Advertising Department, Hicksville, Long Isalnd, New York 11802.



Complete Semiconductor Specs

Motorola has just published a hardbound, 1500-page reference handbook that lists all EIA registered semiconductors. It tabulates 10,500 1N-, 2N-, and 3N-devices made by all manufacturers with their major specifications, and gives equivalents for many of the ones not made by Motorola. In addition, the book includes complete data sheets on over 2800 Motorola semiconductors and a number of application notes and other general information. All semiconductor users should have this valuable book. It costs only $3.95 from any Motorola distributor or by mail from TIC, Motorola Semiconductor Products, Box 955, Phoenix Arizona 85001.

1967 Heathkit Catalog

Heathkit's new 1967 catalog, just off the ›ress, illustrates more than 250 different elec-ronic kits. This 108 page kit-builder's treasure ıas a kit for every interest and every budget. There are complete lines of amateur gear, test ınd lab instruments, stereo/hi-fi components, ›lus many home and hobby items including narine electronics, electronic organs, color elevision and AM and FM radios. This catalog epresents Heath's biggest offering yet, featur-ng many new kits including a deluxe SSB re-:eiver and matching transmitter, SB-series ımateur station console and a signal monitor. To obtain your free copy, send a post card to he Heath Company, Benton Harbor, Michi-ȝan 49022

Dictionary of Electronics

Harley Carter has compiled a most complete lictionary of electronic terms in the latest edition the *Dictionary of Electronics* by the Hart Publishing Company. This dictionary is iberally illustrated and covers the latest levelopments in electronics. In addition to the efinitions of electronic terms, a list of ab-›reviations, symbols, graphical symbols, color codes and conversion tables in included in the ›ack of the book. A very worthwhile buy for he amateur, engineer and technical writer; $2.65 at your book store or write to Hart Publishing Company, 74 5th Avenue, New ork, New York 10011.

New TUCO Catalog

The new catalog from Transistors Unlimited will certainly excite your soul if you're a build-ng ham. It lists hundreds of diodes, transis-tors and other semiconductors, electrolytics, tantalytics and other capacitors, pots, resistors, sockets, test equipment, kits and plenty more. The prices are good, too. Send 25¢ today for catalog 1967S from TUCO, 462 Jericho Turn-ike, Mineola, N.Y. 11501.

Electronic Cable Handbook

The Engineering Staff of the Belden Manufacturing Company has in the *Electronic Cable Handbook,* put together a very complete treatise on the subject of electronics wire and cable. This handbook covers the installation, test, manufacture and use of all types of cable encountered in electronics. There are chapters on coaxial cables for rf, audio and microphone cables, phono pickup and speaker cables, television lead-in, commercial sound and television cabling, intercom and telephone, instrumentation and data processing and automation. All in all, it is a very complete collection of useful facts and figures for users of electronic cable. In addition, this book contains a glossary of electronic terms, a list of military and non-military specifications for wire and cable and many tables of wire and cable operating information. $3.95 at your local distributor or write to Howard W. Sams & Company, Inc., 4300 West 62nd Street, Indianapolis, Indiana.

Multistage Transistor Circuits

Multistage Transistor Circuits by R. D. Thornton et al is just one of a series of eight books produced by the Semiconductor Electronics Education Committee (SEEC). Although this series of books is written specifically for the college undergraduate student, they are very useful to advanced amateurs and electronic technicians familiar with college algebra and the electronics required for transistor circuit design. *Multistage Transistor Circuits* delves into the parameters of multistage circuit design in great depth and presents the effects of external parameters on final circuit operation. Among the subjects covered in this worthwhile book are gain and bandwidth calculations, stability and frequency response of feedback amplifiers, tuned amplifiers, direct coupled amplifiers and broadband amplifiers. Of particular interest is the discussion of the interaction problems between coupled transistor stages and methods of minimizing this undesirable feature. This interaction is of major importance when predicting the high frequency behavior of a particular amplifier circuit. Although this book is much too complex for the casual reader, it presents many subjects to the serious circuit designer that aren't available in other texts. Although *Multistage Transistor Circuits* is very useful by itself, it is much more useful when backed up by the other books in the SEEC series which include *Introduction to Semiconductor Physics, Physical Electronics and Circuit Models of*

Transistors, Elementary Circuit Properties of Transistors, Characteristics and Limitations of Transistors, Digital Transistor Circuits and *Handbook of Basic Transistor Circuits and Measurements.* These books are all available either cloth bound or paper bound, so there is no necessity to spend a great deal to obtain the entire seres. Multistage Transistor Circuits is $4.50 in cloth and $2.65 in paperback. See your local book store or write to John Wiley & Sons, Inc., 605 Third Avenue, New York, New York 10016.

Handbook for Electronic Engineers and Technicians

This new handbook by Harry E. Thomas is an invaluable storehouse of basic electronic information presented in a concise, compact manner. The first six chapters cover the essentials of electronic drafting, sheet-metal construction and workshop practices, electronic components, and wiring and chassis assembly. Chapter 7 provides an insight to the mathematics associated with electronics, covering the fundamentals of arithmetic, algebra, logarithms, trigonometry, and slide rule. The next eight chapters delve into the basics electronic measurement and test, with information on measurement circuits and techniques, simple indicating meters, voltmeters, frequency meters and oscilloscopes. The last six chapters concern the test and checkout of actual electronic equipment, summarizing the equipment and procedures to be used in testing receivers, transmitters, microwave, radar, servomechanisms and power supplies. Each of the chapters on equipment is very complete, with a discussion of operating fundamentals and a concise description of the types of measurements and tests usually required. The chapter on receivers for example includes sensitivity, noise figure, selectivity, signal to noise characteristic, power output, spurious responses, frequency stability, and the equipment and measurement techniques required to determine these characteristics. The last seventy-two pages of the book contain a series of appendices with graphs, tables, and charts covering almost every conceivable facet of electronics. The information contained in these appendices is available from other sources, but this is the first time this reviewer has seen them all collected under one cover. The *Handbook for Electronic Engineers and Technicians* is highly recommended for amateurs, technicians and engineers who need a *one-stop* source of information. $16.95 at your local book store or write to Prentice-Hall, Inc., Englewood Cliffs, New Jersey 07632.

Caveat Emptor?

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ALL MAKES of new and used amateur equipment. Write or call Bob Grimes, 89 Aspen Road, Swampscott, Mass. Tel: 617-598-9700 or 617-598-2530.

CONVERTERS. World's largest selection of frequencies. Ham TV vidicon cameras and parts at low factory-direct prices. See them all now in our full page ad in this issue. Vanguard Labs, 196-23 Jamaica Ave., Hollis, N.Y., 11423.

WE WILL PAY CASH: Wanted, popular, late model unmodified amateur equipment. Highest prices paid for clean good operating gear. Write Graham Radio, Dept. 10, Reading, Massachusetts.

ARE YOU SINCERE? Are you really looking for the best deal on a new or fully guaranteed used unit? Let us convince you with a specific quote that will really save you money. Graham Radio, Dept. 10, Reading, Massachusetts.

MOTOROLA new miniature seven tube 455 kc if amplifier discriminator with circuit diagram. Complete at $2.50 each plus postage 50¢ each unit. R and R Electronics, 1953 South Yellowsprings, Springfield, Ohio.

COMPLETE CONVERSION instructions for the AN/VRC-2, just $1 while the supply lasts. 73 Magazine, Peterborough, N. H. 03458.

WANTED case for Morrow receiver. WA1CCH, c/o 73, Peterborough, N.H. 03458.

SIX ASSORTED ISSUES of ATV Experimenter, circa '64-'65, $1 from 73 Magazine, Peterborough, N.H. 03458.

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KNOB, for Collins 75A-, 6 to 14 reduction, easy to mount. $7 pp. W4VOF, 1517 Rost St., Key West, Fla. 33040.

HW-12 with crystal calibrator. Excellent condition, 1 yr. old. $85. WA9OAZ, 2489 Hwy. X, Oconomowoc, Wisc. 53066.

QSL CARDS—Free samples. Reasonable prices. Send stamped envelope to George WA4QKD, Box 282, Valparaiso, Florida 32580.

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WANTED: Surplus audio bandpass filter #FR-2409. WA7ERA, Route 2, Boise, Idaho 83702.

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WANTED: Case for General Radio 1140A wavemeter. WA1CCH, c/o 73, Peterborough, N.H. 03458.

THE SOUTHERN CAYUGA COUNTY Amateur Radio Club is conducting a nation wide poll on incentive licensing. Send them a postcard with your call and signature stating whether you are for or against incentive licensing. SCCARC—WB2NOD, Box 685, Moravia, New York 131118.

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